THE Petroleum Engineer

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TRETOLITE COMPANY

MANUFACTURING CHEMISTS

DALLAS **SAINT LOUIS** **LOS ANGELES**

Representatives in all Principal Fields

In the great Forests of the Pacific Northwest...

HYDRIL

Internal Flush Drill Pipe Joints Insure SPEED-SAFETY-ECONOMY in Wildcat Drilling

Patented

When this major-company wildcat was planned for the well-nigh inaccessible timberlands, a string of drill pipe equipped with Hydril Internal Flush Drill Pipe Joints was purchased because it exclusively offered these advantages:

The entire fluid passage is smooth and WIDE OPEN, for the diameter of the hole through the tool joints is the same as the I.D. of the pipe.

The maximum volume of circulating fluid is delivered to the bottom of the hole. Drilling is easier, costs are cut, the hazard of fishing jobs is reduced.

Wire line core barrels, bits, surveying instruments, and all "inside-the-pipe" tools are used with maximum efficiency.

The drill string can be used as tubing during production tests, or used as casing if desired. It can be swabbed or bailed.

All drill pipe manufacturers make pipe for Hydril Internal Flush Drill Pipe Joints.

HYDRIL COMPANY

714 West Olympic Blvd. • *Los Angeles*
4300 Calhoun Road • *Houston*
Cable Address: *Hydril*

HYDRIL

THE DIVIDING LINE

BETWEEN SAFETY AND DISASTER.

No operator drilling in any high pressure field can afford to take the risk of a blowout. ● Loss of life and loss of your well and equipment can be avoided by installing Shaffer Proven Control Equipment which has for years been the recognized standard. ● Shaffer Cellar Control Gates have been proven by years of experience. ● They will safely close and hold against the highest pressures yet encountered—and with an ample margin of safety. Two Shaffer Cellar Control Gates require little, if any, more vertical space than one ordinary drilling valve. The use of two Shaffer Cellar Control Gates provides positive protection against blowouts at all times. The upper gate closes around the drill pipe and, when drill pipe is out of the hole, the lower gate effects a complete shutoff. Two remote control features absolutely guarantees the closing of the gates from a distance. ● The Pelton Wheel for use with power and the Handwheel for manual operation.

DON'T GAMBLE WHEN PROTECTION CAN BE POSITIVE

SPECIALISTS IN HIGH PRESSURE DRILLING AND CONTROL EQUIPMENT

SHAFFER TOOL WORKS

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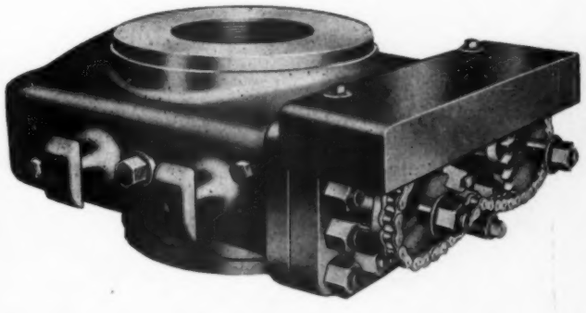
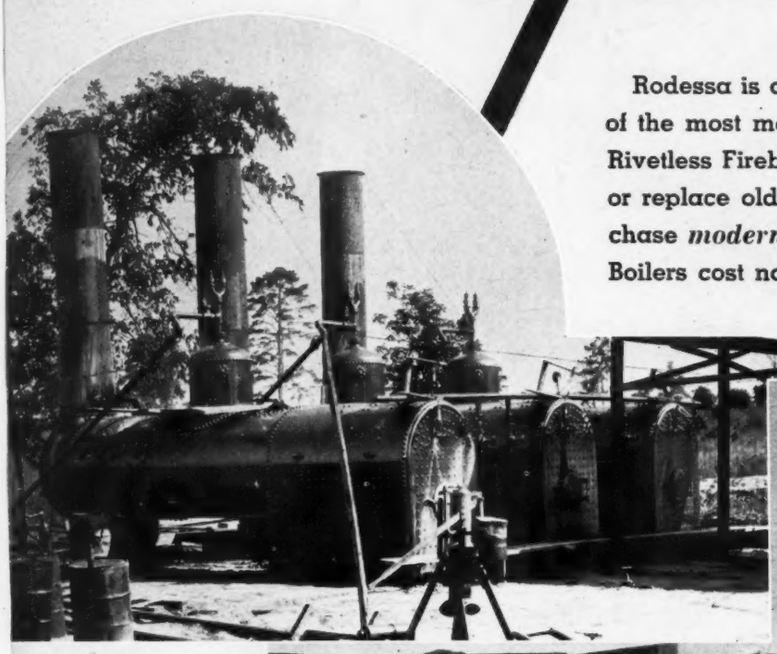


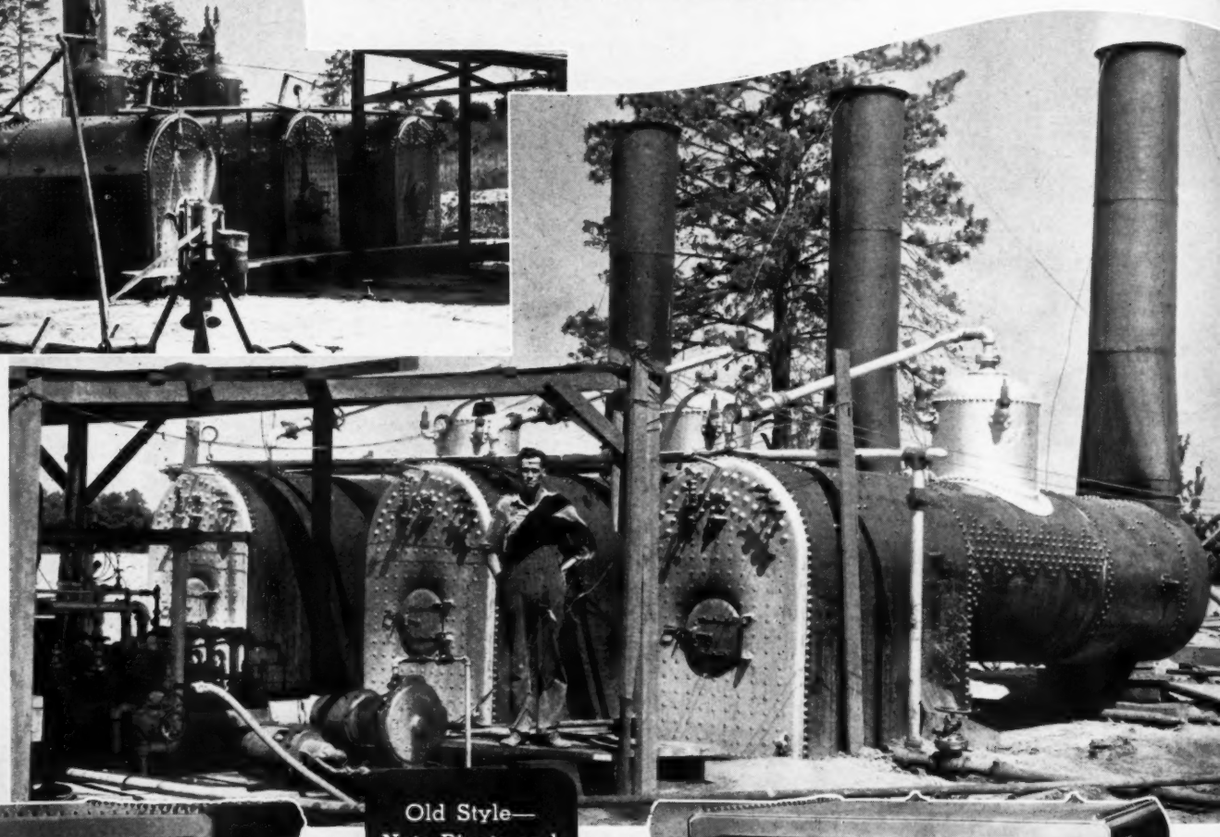
Fishing tools that excel

MODERNIZE *Your Rigs*

Rodessa is a modern, well equipped field. Many of the most modern rigs are equipped with Lucey Rivetless Firebox Boilers. When you buy new rigs, or replace old boilers, you might just as well purchase *modern* boilers. Lucey Rivetless Firebox Boilers cost no more than ordinary boilers.



Battery of Lucey Rivetless Firebox Boilers of Sultana Drilling Co.—Rodessa, La., field.



Battery of Lucey Rivetless Firebox Boilers of R. J. Wolfe — Rodessa, La., field.

STORES AND OFFICES: Rodessa, Shreveport, La.; Hutchinson, Hays, Wichita, Kans.; Oklahoma City, Stonewall, Maud, Okla.

LUCEY EXPORT CORPORATION, NEW YORK AND LONDON

PRODUCTS LUCEY CORPORATION

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OIL WELL SUPPLIES

TULSA, OKLAHOMA

1. EAGLE DREADNAUGHT • Tough metal for bearings subject to extreme speed and heavy pressure.

2. EAGLE OUTLASTA • General service metal for bearings where even speed and pressure conditions prevail.

3. EAGLE DURABLE • A No. 4 bearing metal for all less severe bearing requirements.

Consult your Eagle Bearing Metal Chart for dependable information on which metal to use in each piece of equipment. If you do not have this Eagle Chart, write today for free copy.

EAGLE BEARING SERVICE

After an expert analysis of the operation of your plant, Eagle-Picher will recommend the correct metal to use for each machine. This service is available without charge. Use it — save costly shut-downs, increase your economy of production.

Other Eagle Products used in the oil industry: Eagle Lead Wool and Casings • Eagle Rope Socket Metal • Eagle Sheet Lead • Eagle Insulation • Eagle Sublimed Litharge • Eagle Sublimed Blue Lead.

THE EAGLE-PICHER LEA[illegible] CHICAGO · JOPLIN · CINCINNATI

The Petroleum Engineer, issued thirteen times a year by the Petroleum Engineer Publishing Co., 404-407 Tower Petroleum Building, Dallas, Texas. Subscription price, $2.00 per year, two years $3.00—25 cents a copy. Entered as second-class mail matter May 1, 1932, at the post office at Dallas, Texas, under the Act of March 3, 1879.

PERFECTION *of this new* STRIPPER RUBBER

Makes O-C-T Blowout Preventers Better Than Ever!

O-C-T BLOWOUT PREVENTERS, Type "D" or Type "H", equipped with this perfected Stripper Rubber, simplify drilling in and running casing and tubing under pressure, and make those operations safer than ever.

The design of this rubber permits tool joints and pipe collars to pass through while packing unit is locked around pipe. It also permits rotating of drill pipe to prevent sticking while killing the well.

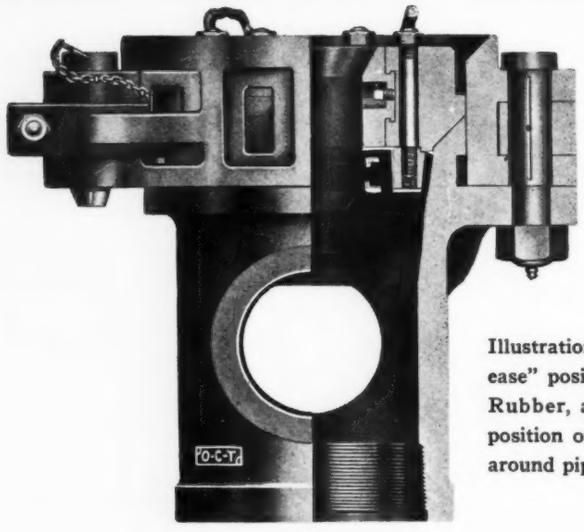
By simply swagging from larger to smaller size pipe, changing pack-off rubbers, and reducing bushings, the O-C-T Preventers handle any size drill pipe, casing or tubing.

OIL CENTER TOOL CO.

HOUSTON, TEXAS, U.S.A.

Selling Through Supply Stores

This Stripper Rubber has been thoroughly tested under the most extreme pressure drilling conditions. Write for detailed information on why it's an outstanding blowout preventer improvement.



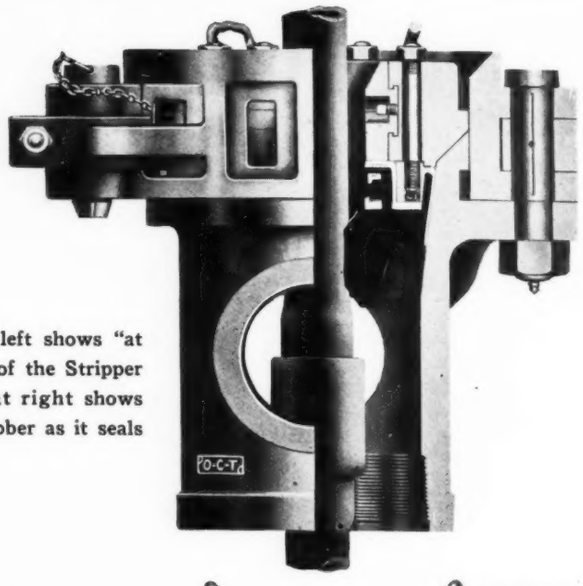
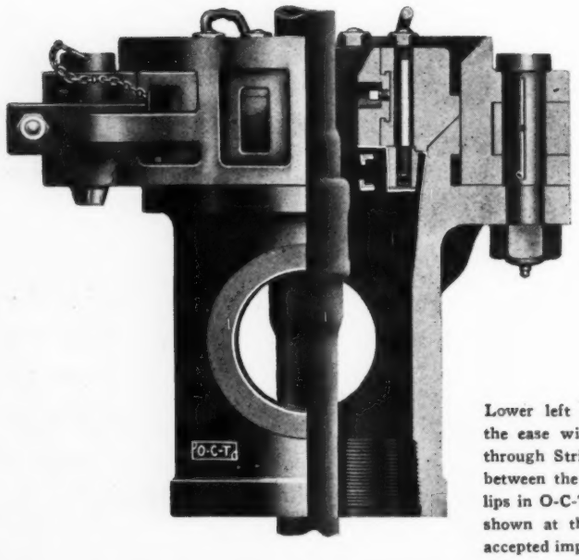
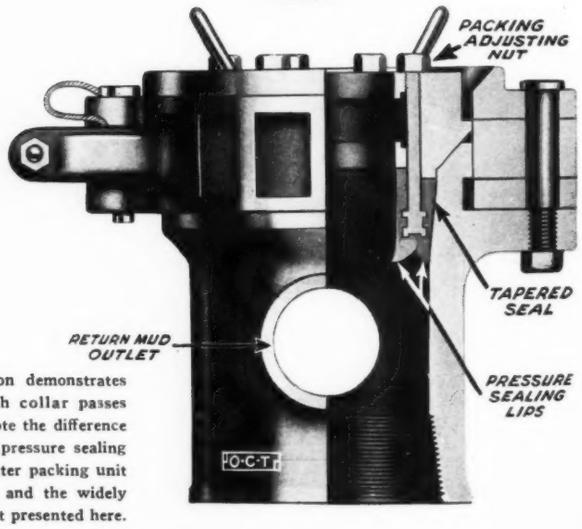


Illustration at left shows "at ease" position of the Stripper Rubber, and at right shows position of Rubber as it seals around pipe.





Lower left illustration demonstrates the ease with which collar passes through Stripper. Note the difference between the original pressure sealing lips in O-C-T Preventer packing unit shown at the right, and the widely accepted improvement presented here.

In Michigan — the Lake State... UNION LINES mean "Smooth Sailing"

There are more than 5,000 lakes in Michigan.

In the *Lake State* oil operators know they can always depend on UNION Wire Lines for "smooth sailing." For wherever they are used, UNION Lines prove that they give longer, more dependable service. They are made from the toughest steels, and have the important advantage of being designed by *oil* men who are thoroughly familiar with *oil* field requirements.

The photograph shows the Daily Crude Oil Company's well, "Jenson No. 1", at Field, Michigan. This well was equipped with a UNION Drilling Line and a UNION Sand Line, and is shown just after it was drilled in. The men in the front row, left to right, are: H. A. "Andy" Corbin and H. F. Frick, Jarecki Mfg. Co.; Crawford Daily, contractor and producer; F. A. Donaldson, Union Wire Rope Corp. Those in the back row, left to right, are: J. A. Moore, Jarecki Mfg. Co.; W. H. Bartlett, George Hansen, Joe Cummings, James Davidson and John Ward—all leasemen employed by the Daily Crude Oil Company.

A Great Vacation State

Michigan is a paradise for vacationists. The cool breezes from her many lakes and her excellent facilities for fishing and boating attract thousands of tourists each year. Michigan has created approximately 50 state parks, to further enhance the natural beauty of her scenery.

No other state has so large a share of America's vast inland seas as Michigan. She is almost surrounded by four of the five Great Lakes, and includes within her boundaries about 40,000 square miles of the Great Lake's water surface. This gives Michigan a shore line of 1,624 miles, which is longer than that of any other state. Off the shores of Michigan lie some 200 islands, many of which have become famous as summer resorts.

See our Exhibit at the Texas Centennial Central Exposition, Dallas, Section 'B', Spaces Nos. 1 and 2, Transportation Bldg.

UNION WIRE ROPE CORPORATION

Executive and Sales Offices: 601 Beacon Life Bldg., Tulsa, Okla.

Factory and General Office: Kansas City, Mo. Branch: Portland, Ore. Warehouse: Monahans, Texas

In Mexico: E. O. CHAPA, P. O. Box 604, Tampico, Tamps, Mexico. Stocks at Tampico

JARECKI MFG. CO.
Distributors: Midcontinent, New Mexico and Eastern Oil Fields

MARION MACHINE FOUNDRY & SUPPLY CO., Rocky Mountain Fields, except New Mexico

Export Agents: (except Mexico) LUCEY EXPORT CORP., Woolworth Bldg., New York; Broad St. House, London

UNION WIRE LINES

The "ULTIMATE LOW COST WIRE ROPE"

Drill pipe on Arkansas' deepest well at Smackover. After finishing well, the Patterson-Ballagh Protectors have original diameter and the tool joints show no excessive wear. Casing is undamaged.

ARKANSAS' DEEPEST PRODUCING WELL

PATTERSON-BALLAGH PROTECTED

ARKANSAS now boasts a new deep drilling field, actually producing from a depth in excess of 5,000 feet. This new record was attained with the aid of Patterson-Ballagh Protectors.

The big majority of deep wells drilled during the past eight years were equipped with Patterson-Ballagh Protectors, which indicates the absolute necessity for this dependable product. Fresh stocks are carried in all principal fields for immediate delivery.

The casing in all the deepest wells in the following states have also been protected with Patterson-Ballagh Protectors:

Deepest well in Texas
Deepest well in Oklahoma
Deepest well in Louisiana
Deepest well in New Mexico
Deepest well in California
Deepest well in Wyoming
Deepest well in Colorado

The deepest wells drilled to date in Mexico and Canada also have been protected with our product.

PATTERSON-BALLAGH PROTECTORS

PATTERSON-BALLAGH CORPORATION

PLANT AND GENERAL OFFICES: 1900 East Sixty-fifth Street, Los Angeles, California, U. S. A.

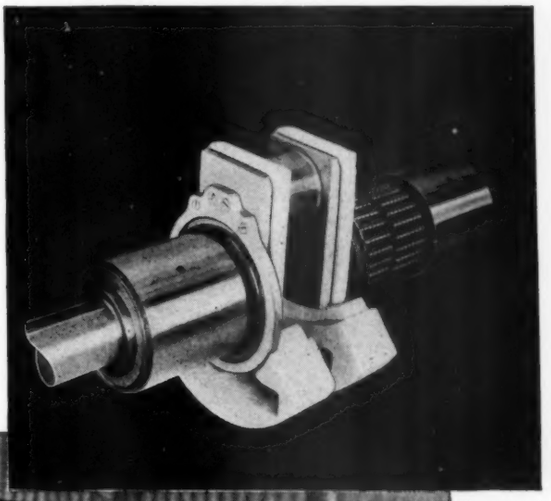
New York Office: 39 Cortlandt Street. Oklahoma Office: Oklahoma City, 1704 N. W. 17th Street. Texas Office: Houston, 515 M. & M. Bldg.
California Warehouse Stocks: Los Angeles, Kettleman Hills, Bakersfield, and Ventura.

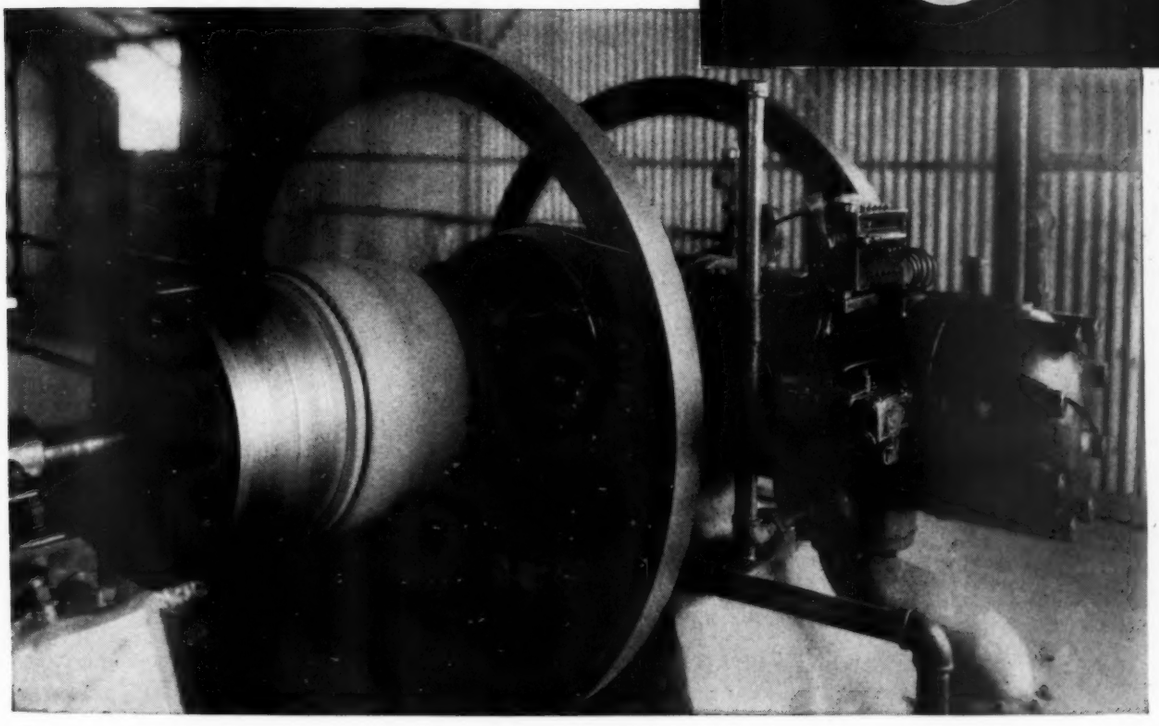
TO KEEP DOWN UPKEEP

...SPECIFY

HYATT

Roller Bearings





Hyatt Roller Bearings are used, as illustrated, on the Crankshaft of WEBER ENGINES built by the WEBER ENGINE COMPANY, KANSAS CITY, MO. Describing this application they state, "After six years of field installations we have never sold a replacement bearing. Such a record speaks for itself for a rugged crankshaft mounted in trouble-free bearings."

For longer life, simplification of design, and freedom from constant maintenance, the manufacturers of better equipment "build-in" Hyatt Roller Bearings. Engineers select Hyatts for long, hard service wherever wear and attention are to be eliminated to the last possible degree. Therefore it pays to specify and get Hyatt Roller Bearings for all your operating equipment. Hyatt Roller Bearing Company, Newark, Detroit, Chicago, Pittsburgh, San Francisco.

AXELSON MANUFACTURING COMPANY
Steel and Reading Genuine Puddled Wrought Iron Sucker Rods—Working Barrels.

BEAUMONT IRON WORKS CO.
Rotary and Pumping Equipment.

BLAW-KNOX COMPANY
Gas Cleaners—Steel Grating—Tracifiers.

DONOVAN BOILER WORKS
Oil Country Boilers.

FOOTE BROS. GEAR & MACHINE CORPORATION
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Packing for All Needs.

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Steam Pumps—Compressors.

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"Sure Grip" line of Pumping Equipment including Grips, Clamps, Beam Hangers, Rod Elevators, Etc.

RAYBESTOS-MANHATTAN, INC.
Raybestos Rotary Brake Lining

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JOSEPH REID GAS ENGINE COMPANY
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REPUBLIC RUBBER COMPANY
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JOHN A. ROEBLING'S SONS COMPANY
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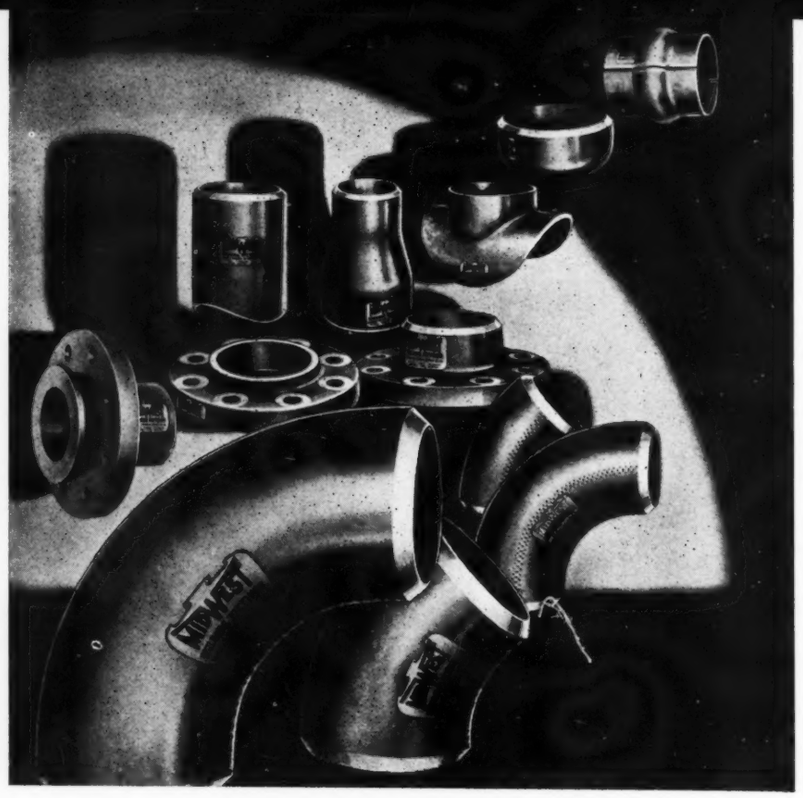
WALWORTH COMPANY
Valves — Fittings — Tools — Lubricated Plug Valves.

WHELAND COMPANY
Slush Pumps—Swivels—Rotary Tables Steam Engines.

WHITLOCK CORDAGE COMPANY
Manila Drilling Cable—Bull Ropes—Cat Lines—Waterflex Cordage.

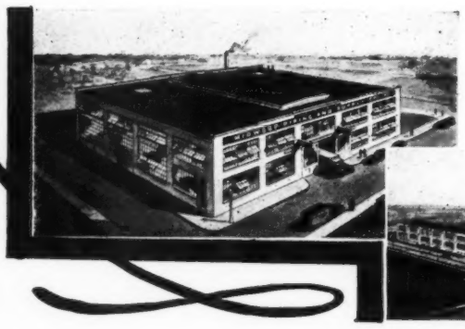


MIDWEST WELDING FITTINGS

IMPROVE THE DESIGN AND REDUCE THE COST OF MANY TYPES OF PIPING SYSTEMS

MIDWEST Welding Fittings appeal to engineers who understand the design, construction and operation of successful piping systems where a definite amount of fluid must be conveyed safely and at minimum cost.

It is almost always possible to SIMPLIFY and SAVE with MIDWEST Welding Fittings.



St. Louis plants where MIDWEST Welding Fittings are made, backed by forty-seven years of experience with piping systems.

FRICK-REID SUPPLY CORPORATION

PITTSBURGH, PA. TULSA, OKLA.

Equipment Suppliers Exclusively . . . Branch Stores in Old and New Fields

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WILL NOW IDENTIFY THEMSELVES BY THIS CARD

Valid only for
SEPTEMBER, 1936.

O. F. Jolly,
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The Petroleum Engineer,
Dallas, Texas.

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This card will serve to identify the bearer, whose photo appears above, as an authorized agent of The Petroleum Engineer, to accept checks or currency in payment of subscriptions at the rate of $2.00 for one year, or $3.00 for two years. Any courtesy extended to this representative will be genuinely appreciated.

THE PETROLEUM ENGINEER,

(Signed) C. R. BARRETT,
Circulation Manager.

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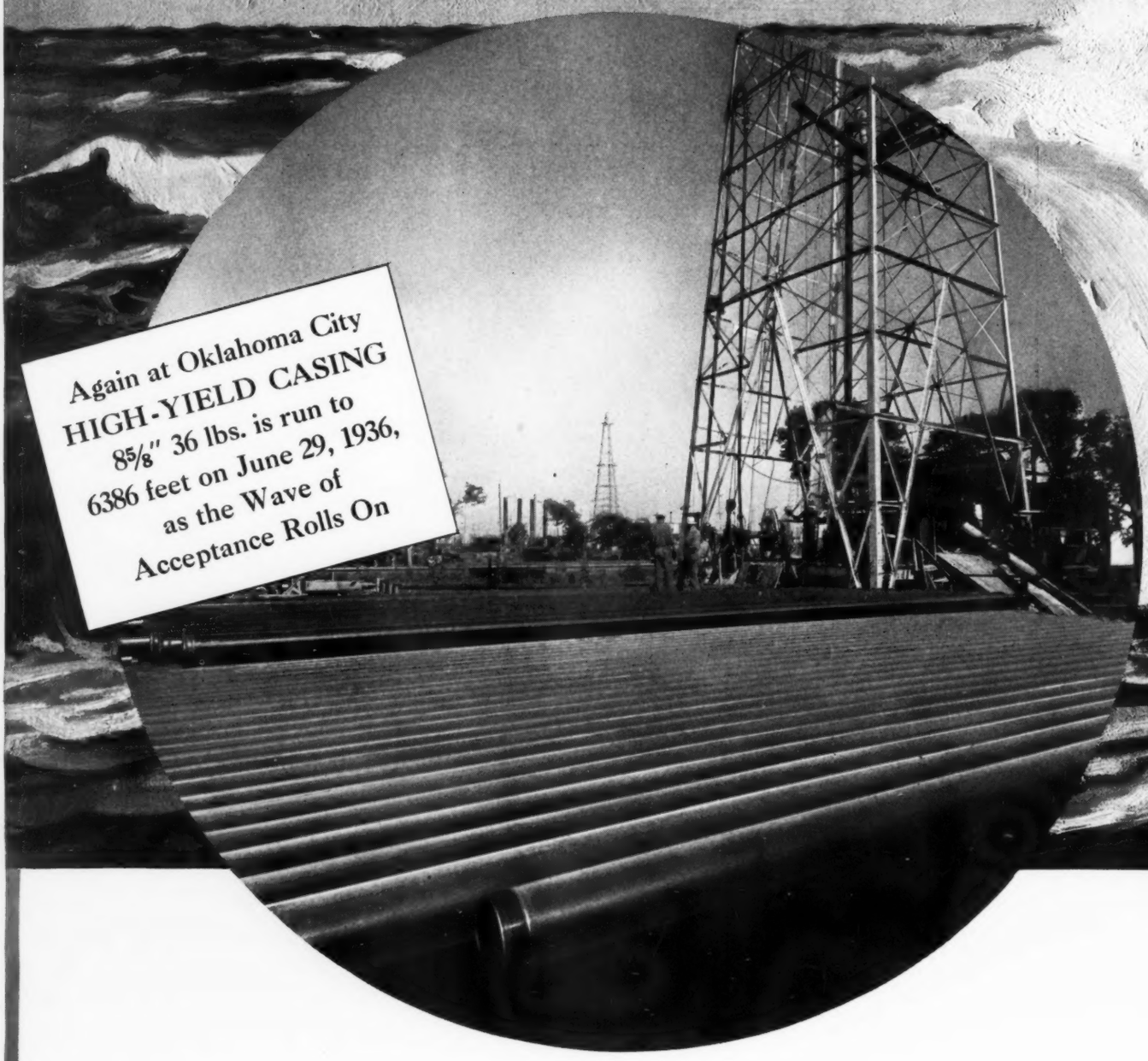
We value highly the cordial welcome and the generous patronage extended our field representatives by the men of the industry and in appreciation we are exerting every effort possible to protect your good will and confidence.

THE Petroleum Engineer

The Wave of Acceptance



Again at Oklahoma City
HIGH-YIELD CASING
8⅝" 36 lbs. is run to
6386 feet on June 29, 1936,
as the Wave of
Acceptance Rolls On

HIGH-YIELD CASING *has:*

GREATER Collapse Resistance
GREATER Pull-Out Strength
GREATER Threading Accuracy
GREATER Make-Up Speed
GREATER Running Speed
GREATER *SAFETY FACTOR*

A. O. SMITH CORPORATION

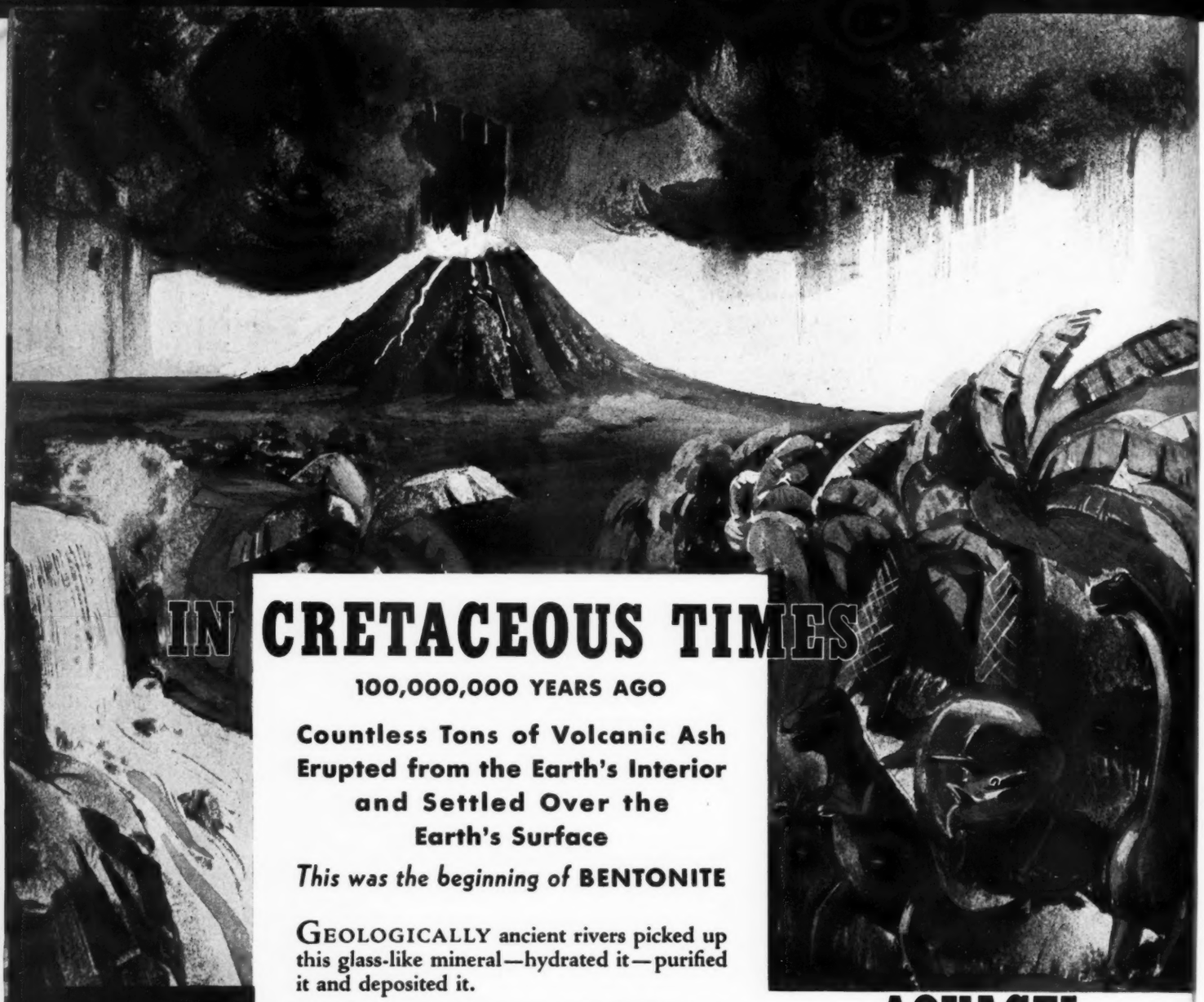
MILWAUKEE, WISCONSIN—*BRANCH OFFICES:* NEW YORK, TULSA, HOUSTON, LOS ANGELES

Manufactured under
U. S. Patent No. 1,993,842
© A. O. Smith Corp., 1936

HIGH-YIELD CASING

GREATER COLLAPSE RESISTANCE · HIGHER PULL-OUT STRENGTH

MORE FOR YOUR MONEY — HIGH YIELD CASING — LOWER-COST WELLS



IN CRETACEOUS TIMES

100,000,000 YEARS AGO

Countless Tons of Volcanic Ash Erupted from the Earth's Interior and Settled Over the Earth's Surface

This was the beginning of **BENTONITE**

GEOLOGICALLY ancient rivers picked up this glass-like mineral—hydrated it—purified it and deposited it.

The Cretaceous Age gave way to the Tertiary. Then came the Quaternary, or modern period, of the world's history. Huge lizard-like monsters fell prey to smaller, quicker and faster-thinking beasts. Man appeared. And throughout these many years, the volcanic ash lost and gained many properties—finally becoming a clay.

In 1898, certain clay-like deposits were described for the first time. These were called BENTONITE after Fort Benton, Wyoming where the deposits were a characteristic feature of the region.

Rotary equipment as a means of drilling deeper wells was first introduced in 1901, and drilling fluids were just the closely available mud until, years later, science brought forth AQUAGEL which has played a leading part in the development of safer, faster, more economical drilling.

TODAY.. AQUAGEL .. A PROCESSED BENTONITE, IS THE IDEAL DRILLING CLAY

In 1928, it was discovered that pulverized and treated BENTONITE was an excellent material for use in rotary drilling. Conceived in fire, BENTONITE was materially unaffected by deep well temperatures; borne by ancient rivers, it was not disintegrated by the waters used in drilling; subjected to ages of overburden, hydrostatic pressures could not alter it.

This same BENTONITE is the basic ingredient of AQUAGEL, which today is used throughout the oil fields of the world because it helps maintain suitable viscosity, suspending cuttings and preventing settling; builds a thin, impervious cake on the walls of the hole, stopping seepage of water into the formation thereby helping to prevent caving; makes it possible to maintain circulation rates with minimum pump pressures and, due to its lubricating qualities, greatly reduces wear on all moving parts.

BAROID SALES COMPANY

LOS ANGELES • TULSA • HOUSTON

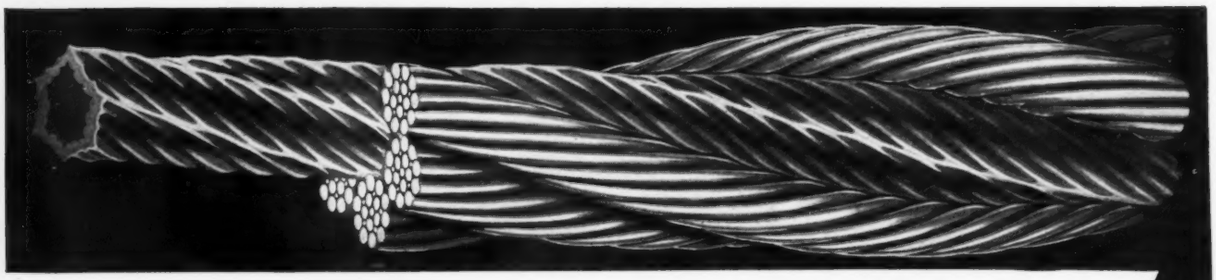
NATIONAL PIGMENTS & CHEMICAL COMPANY, ST. LOUIS

IDEALLY ADAPTED *to all* MODERN FIELD, WELL *and* OPERATING CONDITIONS

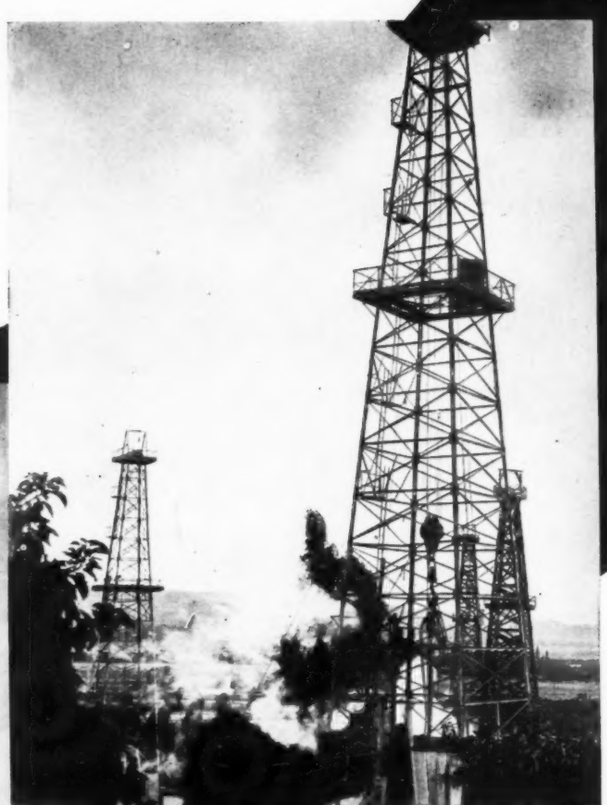
The Kobe Hydraulic method of pumping oil is the result of a long period of research and engineering development, followed by five years of actual service during which time it has been rigidly field-tested and checked. While it has solved a number of major production problems in an entirely satisfactory manner, results in service indicate that this method is equally well adapted to all existing field and well conditions and will develop high volumetric and overall field efficiencies under practically all operating conditions. A large amount of engineering data, and the services of Kobe engineers, are available at all times to oil companies having specific pumping problems, as well as to those which are interested solely in higher pumping efficiencies and reduced production costs.

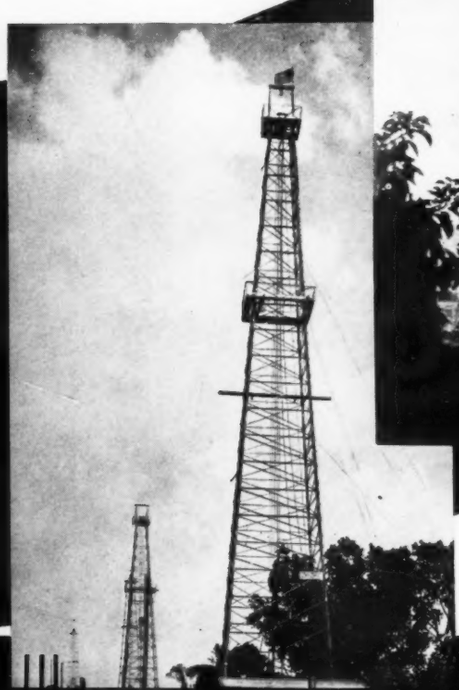
KOBE, INCORPORATED
(Pronounced KŌB)
3040 East Slauson Avenue, Huntington Park, California, U.S.A. Manufacturers of KOBE Heat-Treated Screen Casing and KOBE PUMP.

KOBE All Purpose hydraulic PUMP



Again Williamsport steps ahead with a perfected Rotary Drilling Line in which their exclusive Uni-Zact Core, as illustrated, plays an important part. Drillers are reporting remarkable results from the use of this new Drilling Line.





WILLIAMSPORT WIRE ROPE CO.

Williamsport, Pennsylvania **122 South Michigan Avenue, Chicago, Illinois**

OTHER OFFICES IN ALL PRINCIPAL CITIES

Oil Country Sales Offices: Williamsport Building, Fourth and Midland Valley Tracks, Tulsa, Okla.; 10 North Milby Street, Houston, Texas

Distributors in Texas Louisiana and Arkansas: Mid-Continent Supply Company

General Machine and Tool Company, Distributors in Kansas. . . . American Pipe and Supply Company, Distributors in the Rocky Mountain Territory

In every YOUNGSTOWN pipe-mill, staffs of inspectors, who operate in complete independence of the manufacturing department, constantly check and recheck each step in the manufacturing process. Their job is to make sure that every length of pipe is sound of weld, uniformly strong and ductile, and comes to you pressure-tested, free from flaws and cleanly and accurately threaded. Because they work so hard, your work is made easier.

THE YOUNGSTOWN SHEET AND TUBE COMPANY

Manufacturers of Carbon and Alloy Steels

General Offices - - YOUNGSTOWN, OHIO

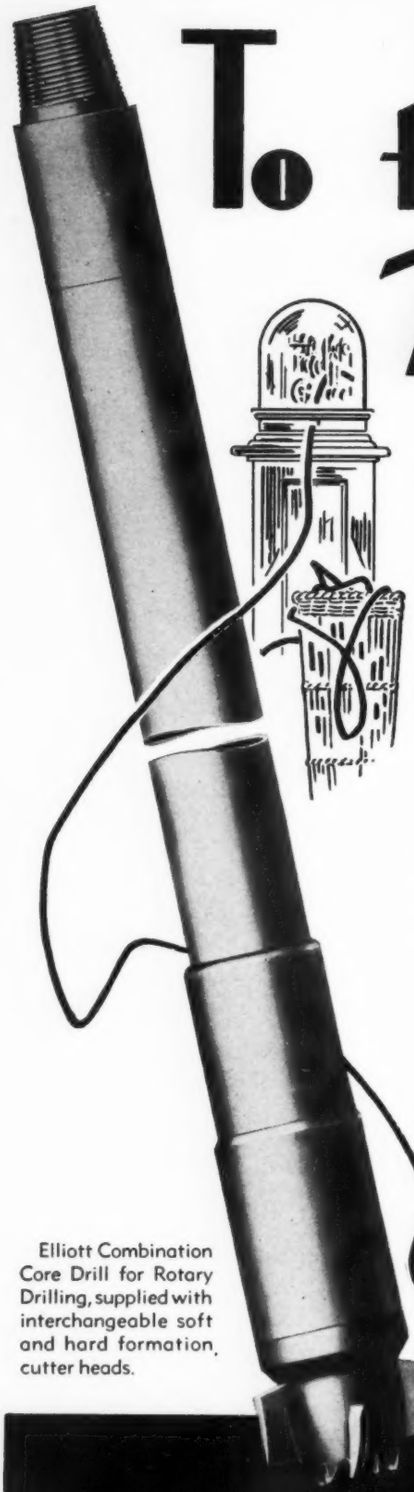
Tubular Products; Sheets; Plates; Tin Plate; Bars; Rods; Wire; Nails; Conduit; Unions; Tie Plates and Spikes.

621

STEEL TRADE MARK YOUNGSTOWN PIPE

DRILL PIPE
CASING TUBING
LINE PIPE

To those who *Must* Gamble



To those who must gamble we sincerely recommend the ponies, stocks, or a hundred other activities where one may risk little and gain much. Taking a chance on a core drill of unknown or questionable merit at the bottom end of a long string of drill pipe, however, involves risks that are entirely too great—with only slight potential gains under the most favorable conditions.

Variations in the purchase or rental price of coring equipment cannot be excessive. Cores and recoveries, however, may prove to be vastly different aside from the tremendous hazards in the hole.

Elliott Core Drills have a performance and recovery record of long standing that is known and recognized throughout the entire world petroleum industry. They are safe, efficient, economical, and thoroughly dependable in service. It is entirely unnecessary to gamble with your well, production, or core recoveries when these master coring tools, with years of expert knowledge and experience by Elliott engineers, are so easily available to operators in all parts of the world.

ELLIOTT CORE DRILLING COMPANY
4731 East 52nd Drive, Los Angeles, California, U.S.A.
Export Office: 420 Lexington Avenue, New York City

Elliott Combination Core Drill for Rotary Drilling, supplied with interchangeable soft and hard formation cutter heads.

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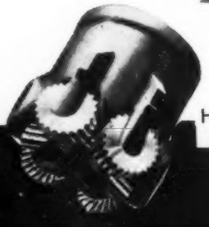
Soft Formation Cutter Head



Hard Formation Cutter Head

ELLIOTT CORE DRILLS

ROTARY AND CABLE TOOL

THE Petroleum Engineer

SEPTEMBER 1936

VOLUME VII NUMBER XIII

A MAGAZINE OF METHODS FOR OPERATING MEN

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R. C. Wipperman
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The Course of Oil

By K. C. SCLATER

Annual Engineering Review This issue, which includes the annual engineering review regularly published in the Midyear number, focuses attention on the progress that has been made during the last year in operating methods and equipment. Some of the more noteworthy engineering advancements are reviewed, among them improved methods of completing deep wells and the better equipment available. Refining progress also is reviewed together with modern practices in natural gasoline recovery, and pipe line construction, operation, and maintenance. The review is a barometer of progress.

Townlot Drilling Act It appears that there are uncertainties and confusion regarding the provisions of the "Townlot Drilling Act" governing townlot drilling in California. Inequities arise from compliance with this Act. This situation has precipitated what amounts almost to a crisis among operators in the Wilmington area. The Industry Affairs Committee of the Oil Producers Agency of California, therefore, will make a comprehensive study of the Act. According to reports submitted to the Committee:

"Operators do not know just what are the outer boundaries of their properties—whether this means the street line or the middle of the street. Where there are two laws covering the same subject, for example the Los Angeles City Ordinance which copied the state act but used other distances, the operator is likely to be told by the 'Mining Bureau' that the street line is his outer boundary, and the city official will tell him to figure to the middle of the adjacent street . . . this boundary feature should be clarified so that the operator will not have to run the risk and incur the legal expense of boring into the title to the adjacent street to determine whether the highway is the subject of a mere surface easement or something like that, or of an outright grant.

"It is apparent . . . that where, as may happen in Wilmington, there are two or more producing zones, the owner of the small lease quite properly may desire to drill a well into each horizon. Considering the setback distances from the boundaries, and the distance of 150 feet between wells, in many instances the holder of a comparatively small parcel must sacrifice production from one or more zones in order to comply with the Act. This restriction should be relaxed for such events . . . perhaps the escape will be to permit more intensive or closer drilling when steel derricks are used, instead of wooden, with, perhaps, some further fire protective factors such as walls or dikes.

"In new areas some rank injustices are developing (under the present Townlot Drilling Act). Take a community lease situation. It is possible under the Act for an operator to take part of a block, leaving holes in it, and thus leaving the owner of the small 'hole' out of the picture and unable to obtain drilling on his own land or to participate in production at all. For this reason there are grave doubts as to the constitutionality of the Act.

"The present 'Townlot Drilling Act' contrasts strangely with the city ordinance which was upheld in Marrs vs. City of Oxford (32 F. 2d 134, 67 A. L. R. 1336; U. S. C. A. 8th; 1929). There the ordinance of Oxford, Kansas, permitted the drilling of one well on each city block. The operator had to obtain a city permit. A condition of the permit was, in substance, that all property in the block must participate in the royalty whether included in the lease or not. The difference between the fairness of that type of law and the unfairness of the California Act, is apparent."

It is obvious that the Townlot Drilling Act needs clarification; its amendment should benefit both oil men and land-owners.

Stabilizing Crude At the Well Evaporation of crude oil from the time the crude comes from the well until it is refined has always been a source of great loss in the petroleum industry. In recent years this loss has been reduced by the use of vapor-tight tankage and by judicious handling of the crude in the field. But despite this progress there still remains much room for improvement. In this connection it is not only interesting but encouraging to note the effort that one major company is making to reduce its evaporation losses between the well and the refinery. The means adopted for doing so consist of stabilizing the crude immediately it comes from the well. The oil and gas production is passed through a modern crude stabilization plant erected in the field and all the light ends of the crude oil and the heavy components of the gas are removed and gasoline recovered before the crude is delivered to storage or to the pipe line. In this way it is hoped to cut down sixty per cent or more of the vaporization losses that otherwise would occur. It happens that in this case the company controls all the productive acreage in the field, a circumstance that favored the installation of an efficient plant for the stabilization of the crude and the recovery of gasoline. Investigations also have been made with regard to the feasibility of embarking on a pressure maintenance program by returning all residue gas to the producing sand, and plans are now in the making for carrying out such a program. The crude stabilization and gasoline recovery plant is the subject of a special article in this issue. Being a pioneer undertaking of its kind this plant is significant as indicating a trend in modern oil production practice. It is a truly constructive departure from orthodox methods for the conservation of crude oil and natural gas energy.

« « « HIGHLIGHTS IN OILDOM » » »

Embargo on Oil Concession Grants Ended

The Colonial Secretary of the United Kingdom has stated that, subject to certain conditions, the embargo has been raised on the granting of oil concessions to foreigners, or foreign-controlled companies generally, throughout the Colonial Empire. Concessions will be given only in instances where the foreigners concerned are citizens of countries granting similar advantages to British nationals, however, and the majority of the employees must be British subjects.

Another stipulation is that as soon as the output of oil reaches a specified volume, at least 50 percent will have to be refined on British territory and the plant made capable of producing fuel oil suitable for Admiralty use. The change will become effective September 1, 1938.

●

Extracting Oil From Tar Sands

The problem of extracting oil from tar sands apparently has been solved. Equipment has been devised by Abasand Oils, Ltd., of Waterways, Alberta, Canada, following seven years of experimentation. The machine has been given a test and officials of the company are pleased with the result.

In operation the sand enters the machine through a hopper, is mixed with hot water, and washed thoroughly a number of times, eventually the oil pouring out one vent and the sand and water out another. The machine is electrically driven and when installed requires only ten hp. and two men to operate. It is placed on a movable chassis and pushed up against the face of the sand cliffs.

Alberta is said to possess the largest quantities of tar sand in the world. The oil produced from the sand has an asphalt base.

●

East Texas Pressures

The East Texas field has retained more than half its recent gain in bottom-hole pressure, engineers reported at the oil and gas proration hearing of the Texas Railroad Commission this month. Recent losses were not great enough to cause material change, if any, in the existing factor of 2.32 percent of the hourly potential of the well. From July 12 to August 12 bottom-hole pressure in the field rose 6.8 lb., while from August 12 to September 10 it declined 3.5 lb. per sq. in., to 1183.5 total. Since the allowable during the latter period was 12,572,134 bbl., the pressure drop was but .278 lb. per million barrels allowable.

●

Recommends Gas-Oil Ratio For Rodessa

Recommendations have been made by the Louisiana Operators' Committee that the gas-oil ratio of the Louisiana side of the Rodessa field be held to 12,500 cu. ft. per barrel. Under the present per well allowable of 240 bbl. a day this would mean 3,000,000 cu. ft. of gas per well. The recommendation was based upon results of a study by the committee's engineers. The investigation, which covered a period of three weeks, revealed that gas waste on the Louisiana side of the Rodessa field is approximately 500,000,000 cu. ft. daily from approximately 260 wells.

The engineering study was directed by H. W. Bell, whose engineers selected 65 key wells for the purpose, 46 of which were found to have a high gas-oil ratio. During the course of the investigation it was found also that gas pressure in the Louisiana part of the field was dropping at the rate of three lb. per day, or a total of 152 lb. for a 51-day period ending August 27th.

●

World's Deepest Producer

As a result of the completion on September 12 of Abercrombie and Harrison's No. 1 Armstrong Plantation at a total depth of 9963 ft. in the Old Ocean field, Brazoria County, Texas, is laying claim to the world's deepest oil well producing by natural flow. It was completed producing 13 bbl. of oil an hour while cleaning itself through ¼-in. choke, thus honors are taken away from the 9800-ft. well of the Associated Oil Company at Ventura, California.

Operators reported the Abercrombie and Harrison well initially flowed 54-gravity crude under fluctuating pressures of 2900 to 3200 pounds. This strike opens a new producing sand for the Old Ocean field, 1300-ft. below the former producing depth.

●

Forty-Acre Spacing for Cotton Valley

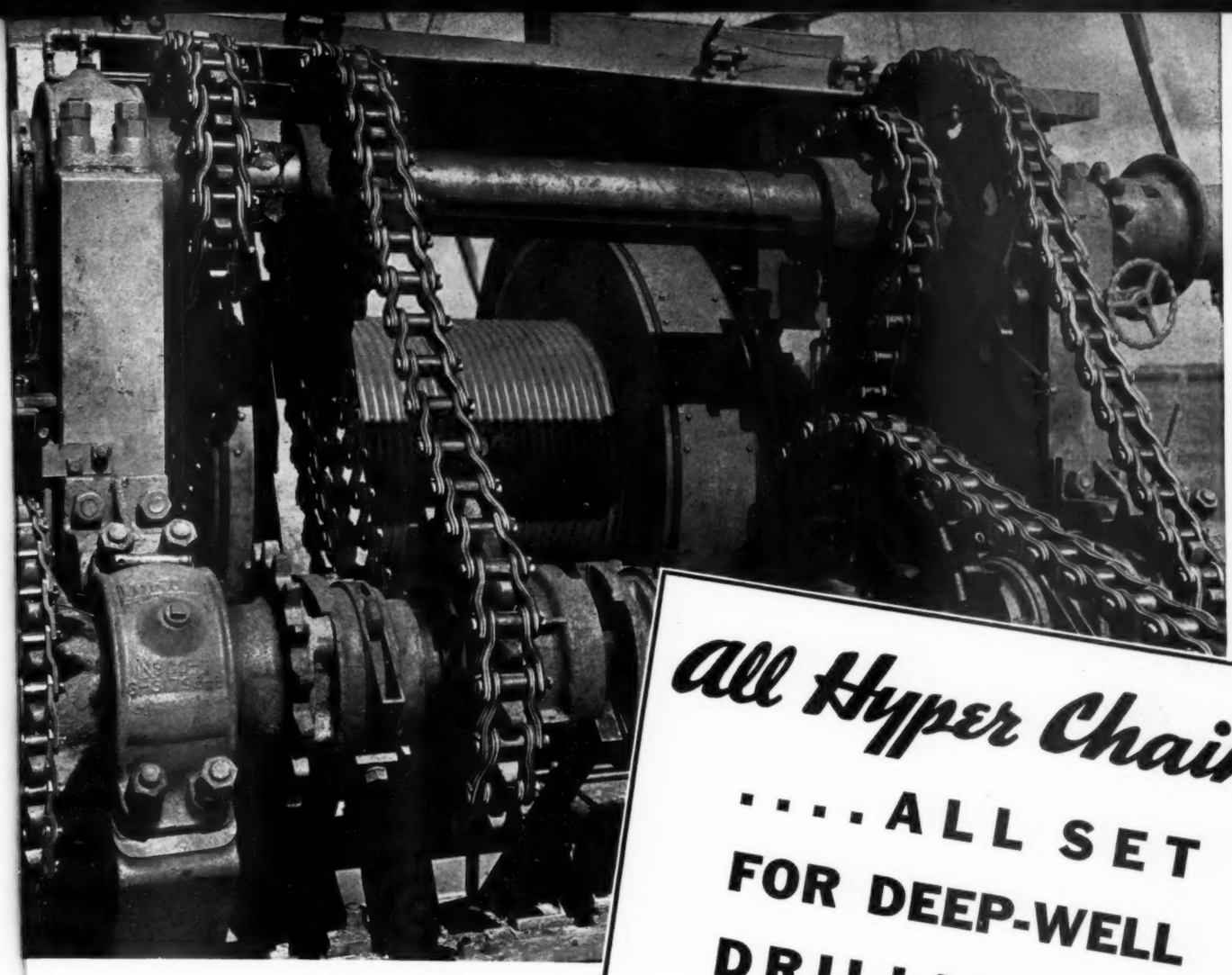
W. G. Rankin, state conservation commissioner, has announced a spacing rule of one well to each 40 acres in the Cotton Valley field of Webster Parish, Louisiana, where interest has been revived by the discovery of deep production in the Travis Peak. The ruling provides that violators will not be permitted to produce either oil or gas, and wells will be plugged, closed, and sealed.

The regulation also calls for locations to be made in the center of the 40-acre tract. Pooling of small tracts will be permitted. Hearings will be held on permit applications for drilling on tracts of less than 40 acres, and should the department so decide, exceptions to the rule will be issued.

●

Potential Decline At Oklahoma City

Tests made on the first 156 Wilcox sand wells in the Oklahoma City field reveal that the potential is declining. The tests gave the 156 wells a potential of 836,573 bbl., a drop of 27.96 percent from the old potential established last April. The figures were made public by the state oil and gas conservation officer.



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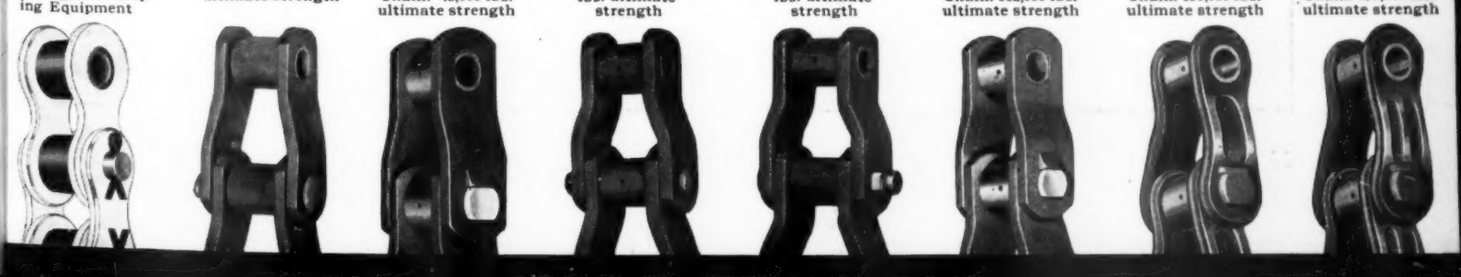

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LATEST ACTIVITIES IN THE OILFIELDS

THE Ohio Oil Company's discovery of oil in the Travis Peak formation in the Cotton Valley field of Louisiana is considered of extreme importance inasmuch as it makes possible the finding of production in the same formation in other old fields of the northern part of the state and gives promise of resulting in active drilling campaigns in such areas. Ohio's No. 1 R. L. Holloway was completed at a total depth of 5552 ft., after plugging back from 8556 ft., and made an initial flow of 415 bbl. of 45.5-gravity oil through ⅜-in. choke.

●

Oil production has been extended into Pawnee County, Kansas, by No. 1 Gates wildcat of Simpson & Noble, 11 miles northeast of Larned. The well was drilled to a total depth of 3841 feet. Initial production, which is from the Arbuckle lime, was 100 bbl. of oil and 5,000,000 cu. ft. of gas daily.

●

A good showing of oil in Callaway-Crosby-Porter's No. 1 White Point Development Company gives promise of definitely establishing the White Point gas field of San Patricio County, Texas, as an important oil field. Sand was cored at 4900-15 ft. and on a drill stem test 510 ft. of oil was obtained in five minutes. The field is in the Corpus Christi area, across Nueces Bay from the Saxet field.

●

A half mile extension to the south has been given the Lance Creek field of Wyoming by MacKinnie Oil and Drilling Company's No. 1 Thompson. At a depth of 3993 ft., production was at the rate of 53 bbl. of oil per hour, the flow being through 2-in. tubing. Production is from the Sundance and the crude is of 46.4 gravity.

●

Three new pools have been added to southern Oklahoma's total within recent weeks. No. 1 Cathey of The Texas Company, southeast of Hewitt in Carter County, flowed 150 bbl. of oil in two hours. Later it was drilled to 4400 ft., and the hole filled 4000 ft. with oil. Sinclair Prairie Oil Company's No. 1 Stockton in Love County, at a depth of 8583 ft., initially swabbed 303 bbl. of oil and 112 bbl. of water in 24 hours. Later it made 40 bbl. of oil during a like period and was to be reacidized. In Garvin County, Winkler & McQueen, Inc., with their No. 1 Davis, found production at 2676 ft., the well making 240 bbl. of oil in three hours.

●

Frank Gravis' No. 1-A Shallert has found oil production on the northwest flank of the Palangana salt dome of eastern Duval County, Texas. Production is from the Jackson sand at 2730-44 ft., and is expected to result in further exploration of salt dome prospects in the area.

●

The Kansas Oil Development Corporation and the Creekmore Oil Company have opened a new oil-producing area in Ellis County, Kansas, with their No. 1 Haller. Six miles west of the Bemis pool, the test pumped 462 bbl. of oil the first 13 hours. Production is from the Topeka lime at a total depth of 3050 feet.

●

The Reserve Oil and Gas Company has had a showing of oil in its wildcat test No. 33-2 Tejon, in the Grapevine area 25 miles south of Bakersfield, California. Total depth is 4508 ft., sand being cored at 4447-4490 ft., and wet, oil-stained sand cored at 4490-4508 feet.

●

Michigan's first commercial gas production from the Berea sand has been found in Arenac County by McClanahan Oil Company's No. 1 Buffalo Land Company. Gas was logged from 1126 to 1133 feet.

AVERAGE CRUDE PRICES

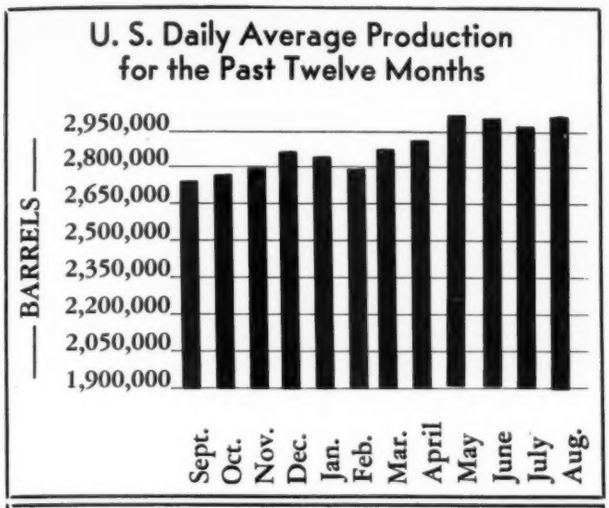
California	
Kettleman Hills	$1.22-1.43
Playa Del Rey	1.10
Coalinga	.70-.90
Signal Hill	1.10
Montana	1.45
Wyoming	1.10
Colorado	1.00-1.10
New Mexico	.75-.95
Texas	
North Central	.84-1.08
Panhandle	.81-.98
West Texas	.75-.95
Gulf Coast	.85-1.30
Darst Creek	.88-1.22
East Texas	1.15
Kansas	1.10
Oklahoma	1.10
Arkansas	.75-.80
Louisiana	
Gulf Coast	$ .82-1.22
North Louisiana	.86-1.10
Illinois	1.23
Kentucky	1.23
Indiana	1.12
Ohio	
Lima	1.25
Michigan	1.12
Pennsylvania	
Bradford	2.45
Southwest	2.17
Eureka	2.12
Buckeye	1.97
Corning	1.42
West Virginia	1.67
Canada	2.10-2.17

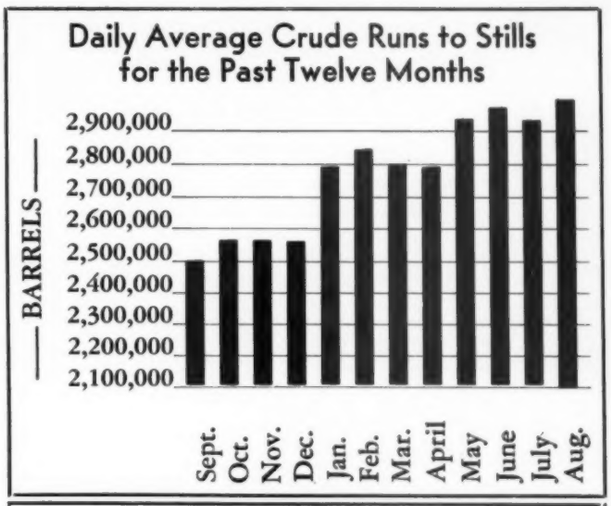
DAILY CRUDE OIL PRODUCTION

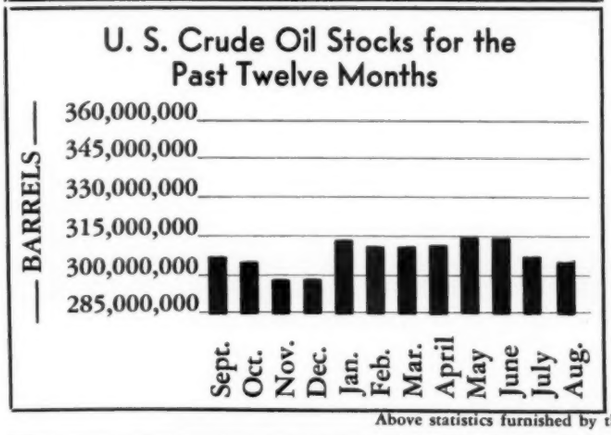
Data Supplied by A.P.I.

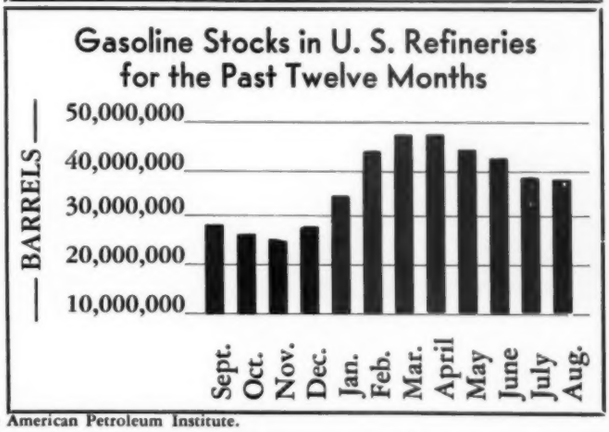
(Figures in Barrels)

	B. of M. Dept. of Interior Calculations (August)	Week Ended Aug. 29 1936	Week Ended Aug. 1 1936	Week Ended Aug. 31 1935
Oklahoma	575,500	572,300	541,100	471,700
Kansas	166,500	172,450	156,000	139,750
Panhandle Texas		64,050	61,950	51,950
North Texas		61,450	59,850	57,600
West Central Texas		26,550	26,300	25,800
West Texas		182,150	180,250	150,000
East Central Texas		61,450	57,650	47,850
East Texas		434,300	429,100	439,250
Southwest Texas		87,400	84,300	58,600
Coastal Texas		260,250	252,900	187,650
TOTAL TEXAS	1,154,700	1,177,600	1,152,300	1,018,700
North oLuisiana		81,200	84,150	24,550
Coastal Loiusiana		152,750	147,750	120,900
TOTAL LOUISIANA	188,500	233,950	231,900	145,450
Arkansas	31,200	29,100	29,650	30,300
Eastern	110,800	113,700	113,200	102,600
Michigan	32,400	31,250	35,500	48,050
Wyoming	38,600	41,550	39,150	38,050
Montana	13,900	18,750	15,700	13,200
Colorado	4,700	4,850	4,650	4,400
New Mexico	70,100	78,050	74,150	57,200
TOTAL EAST OF CALIF.	2,386,900	2,473,550	2,393,300	2,069,400
California	550,000	558,500	554,700	595,700
TOTAL U. S.	2,936,900	3,032,050	2,948,000	2,665,100









Above statistics furnished by the American Petroleum Institute.

Summarized Operations in Active Fields for August, 1936

Fields	Completions	Producers	Rigs	Drilling Wells	Depth of Production	No. Casing Strings	Gravity of Oil	Type of Tool Used
TEXAS								
East Texas	234	225	72	94	3500-3700	2	40	Rotary
Duval County	82	78	37	60	1554-2900	2	22	Rotary
Archer County	37	19	14	25	660-1800	1 or 2	40	Rot.-Cab.
Panhandle	48	45	41	165	1700-3900	2	40	Rotary
Refugio County	9	8	2	11	4900-5900	2	38	Rotary
Nueces County	49	48	10	35	3922-5878	2 or 3	22.5-40	Rotary
San Patricio County	15	11	3	8	3987-6141	2	24.5-40	Rotary
Sam Fordyce	6	3	3	7	2833-3200	2	21.5	Rotary
Talco	30	29	13	30	4230-4361	2	16-24	Rotary
OKLAHOMA								
Oklahoma City	41	37	17	52	6450-6682	3	39	Rotary
Fitts Field	42	41	20	76	1800-4488	2 or 3	38	Rotary
Osage County	27	22	7	36	380-2850	2	37.5-40	Rot.-Cab.
KANSAS								
McPherson County	7	6	5	17	2900-4300	2	38	Rot.-Cab.
Russell County	24	16	10	40	2926-3435	2 and 5	42-48	Rot.-Cab.
Rice County	23	16	8	39	3222-4085	2 and 5	42-48	Rot.-Cab.
Reno County	18	16	2	29	3300-4375	2 and 5	42-48	Rot.-Cab.
LOUISIANA								
Rodessa	31	31	30	85	5950-6450	3	39	Rotary
CALIFORNIA								
Kettleman Hills	7	7	3	26	8300-8730	3 or 4	40	Rotary
Midway-Sunset	7	7	10	21	1400-3100	1 and 2	11-30	Rot.-Cab.
Mountain View	2	2	6	9	5200-6000	2	20-40	Rotary
Montebello	2	2	6	10	5000	2	36	Rotary
Round Mountain	6	6	1	6	1600-2400	1	16-18	Rotary
Kern	6	2	6	5	1000-1200	1	12-15	Rotary

Field Activities by States for August, 1936

State	Completions		Producers		Locations		Rigs		Drilling Wells		Production, 1935 (In Barrels)
	August	July	August	July	August	July	August	July	August	July	
Arkansas	13	14	1	3	10	4	7	12	32	30	11,140,750
California	65	82	55	76	113	103	104	124	281	238	207,899,480
Colorado	2	....	0	....	....	....	4	5	34	33	1,565,150
Illinois	....	9	....	5	....	....	20	21	18	17	4,352,000
Indiana	10	12	6	9	....	....	3	8	27	30	762,000
Kansas	141	184	100	140	189	141	49	51	338	274	53,013,450
Kentucky	33	33	26	26	....	....	5	5	18	22	4,860,000
Louisiana	85	95	70	72	102	76	45	62	187	211	50,299,950
Michigan	65	74	42	60	78	70	67	79	131	125	15,661,350
Mississippi	....	1	....	0	....	....	3	2	9	11	Gas. Prod
Montana	16	21	13	18	....	....	10	14	64	69	4,304,100
New Mexico	50	52	48	50	....	....	20	23	108	124	19,195,500
New York	....	....	....	....	....	....	1	2	6	8	3,191,900
Ohio	148	166	141	120	....	....	64	51	203	197	4,234,000
Oklahoma	252	319	197	267	266	207	70	64	548	536	181,152,050
Pennsylvania	....	....	....	....	....	....	18	20	132	136	14,478,000
Texas	1027	1194	820	902	1632	1107	620	645	1812	1802	377,747,205
West Virginia	64	32	52	24	....	....	30	34	149	151	3,818,400
Wyoming	13	8	9	7	....	....	7	12	63	62	13,390,100
Totals	1984	2296	1580	1779	2390	1708	1147	1234	4160	4076	970,935,385

THE MONTH'S ACTIVITIES IN REFINING

Percent Refinery Capacity Operated

Western Division, 75.7 percent **Central Division, 78.5 percent** **Eastern Division, 82.6 percent**

THE ETHYL GASOLINE CORPORATION will construct a $2,000,000 plant in Baton Rouge, Louisiana, it has been announced by E. W. Webb, president. One hundred and ninety acres, situated north of the Standard Oil Company's refinery, have been purchased, and construction work will begin about October 1st.

●

According to reports, American and English petroleum circles are keenly interested in a new Italian hydrogenation process. A plant will be constructed at Leghorn and another at Bari. At Bari the heavy oil from Albania will be processed. This oil will be transported by the Azienda Italiana Petroli Albania through a recently completed 85-kilometer pipe line from the Kucciova oil fields to the port of Valona, Albania, thence by sea route in six hours to Bari. It is estimated that total production of the two plants will be 240,000 tons of gasoline per annum. It is probable that a third hydrogenation plant will be erected in the Valdarno in the Province of Florence for the processing of lignite and bituminous shale.

●

The Shallow Water Refining Company is erecting a 500-bbl. capacity refinery 13 miles south of Scott City, Kansas. It will serve as an outlet for the Shallow Water field. Plans allow for the future expansion of the plant to 1500 to 2000 bbl. daily capacity.

●

The Ida Oil and Refining Company, with headquarters at Ida, Louisiana, has been incorporated, and a small refinery will be constructed in the Rodessa field in the near future. Officials of the company are C. R. Obermeyer, president and treasurer; L. F. Perretz, vice-president, and C. B. Anderson, secretary.

Soviet Russia will construct 16 new refineries by the end of the year, it has been announced by the U.S.S.R. at Moscow. Being erected now near Moscow is the plant of the Aviotop (Aviation Fuel) Trust, which will produce approximately 5,000,000 bbl. of gasoline, fuel oil, and asphalt annually.

●

The plant of the United Refining Company at Warren, Pennsylvania, having a crude oil capacity of 3000 bbl. daily, is undergoing certain improvements and additions. The cracking plant is being added to, approximately 30,000 bbl. additional storage is being provided, and a new boiler house is being constructed.

●

The new natural gasoline plant of the Rodessa Gasoline Company, in the eastern end of the Rodessa field, has been placed in operation. It is of the absorption type, and has a daily capacity of 40,000,000 cu. ft. of gas, although it is not operating at capacity as yet. Hebert E. Dickard and Company, Monroe, Louisiana, were the construction contractors.

●

The Santa Rita Oil Company, of which L. B. O'Neil is president, is constructing a refinery of the cracking type at Cut Bank, Montana. It will be operated by a subsidiary company, the Northwest Refining Company. The plant's capacity will be 2500 bbl. daily and it is expected to be in operation by the end of the year.

●

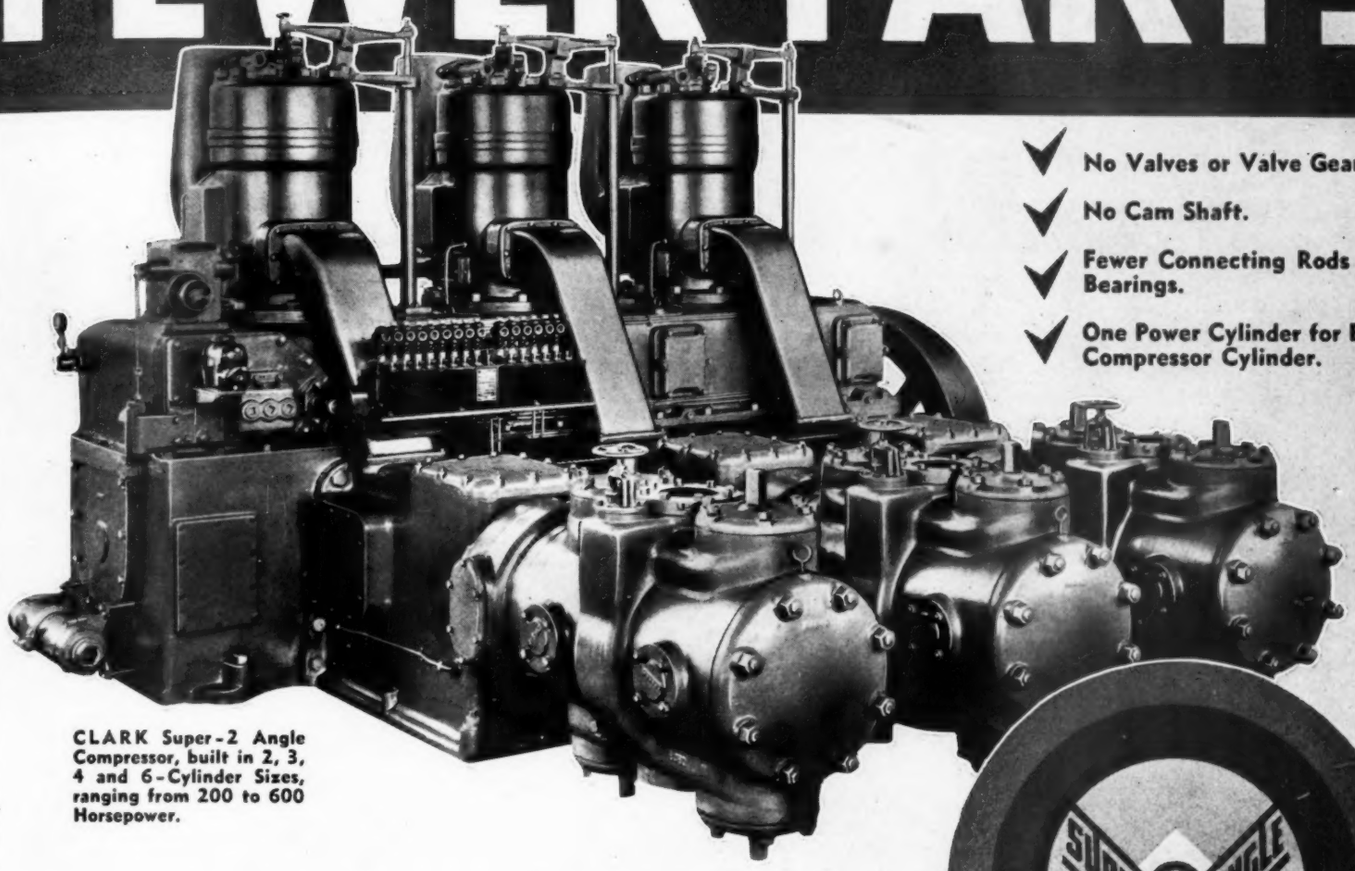
The Empire Oil and Refining Company is erecting a natural gasoline plant of the absorption-compression type 12 miles north of Odessa, Texas. Its capacity will be 35,000,000 cu. ft. of gas daily. A gasoline line also will be laid to transport the product of the plant to a loading rack near Odessa on the Texas and Pacific railroad. Approximately 87 wells will supply the plant with gas.

Crude Runs to Stills, Gasoline and Gas and Fuel Oil Stocks
Week Ended August 29, 1936
A.P.I. Figures
(Figures in Barrels of 42 Gallons Each)

DISTRICT	Percent Potential Capacity Reporting	Daily Avg. Crude Runs to Stills	Percent Operated of Total Capacity Reporting	Total Motor Fuel Stocks Thousands of Bbl.	Gas and Fuel Oil Stocks Thousands of Bbl.
East Coast	100.0	512,000	83.7	16,952	11,649
Appalachian	94.8	104,000	71.2	2,128	582
Ind., Ill., Ky.	96.1	412,000	92.8	8,584	5,814
Okla., Kans., Mo.	84.8	292,000	76.0	5,595	3,494
Inland Texas	48.5	119,000	74.4	1,308	1,727
Texas Gulf	96.8	643,000	97.7	6,542	8,919
La. Gulf	96.4	136,000	83.4	1,742	2,255
No. La.-Ark.	90.0	44,000	61.1	269	367
Rocky Mt.	61.9	50,000	83.3	903	811
California	92.6	538,000	68.2	11,942	73,126
Reported	89.7	2,850,000	81.7	55,965	108,744
Est'd. Unreported	.....	200,000	.....	4,468	2,251
*EST'D TOTAL U.S. Aug. 29, '36	.....	3,050,000	.....	60,433	110,995
*EST'D TOTAL U.S. Aug. 22, '36	.....	2,975,000	.....	61,071	110,628
U. S. B. of M. August, 1935	.....	2,729,000	.....	**51,700	**109,282

*Bureau of Mines basis currently estimated.
**As of August 31, 1935.

FEWER PARTS



- No Valves or Valve Gear.
- No Cam Shaft.
- Fewer Connecting Rods and Bearings.
- One Power Cylinder for Each Compressor Cylinder.

CLARK Super-2 Angle Compressor, built in 2, 3, 4 and 6-Cylinder Sizes, ranging from 200 to 600 Horsepower.

SUPER 2 ANGLE

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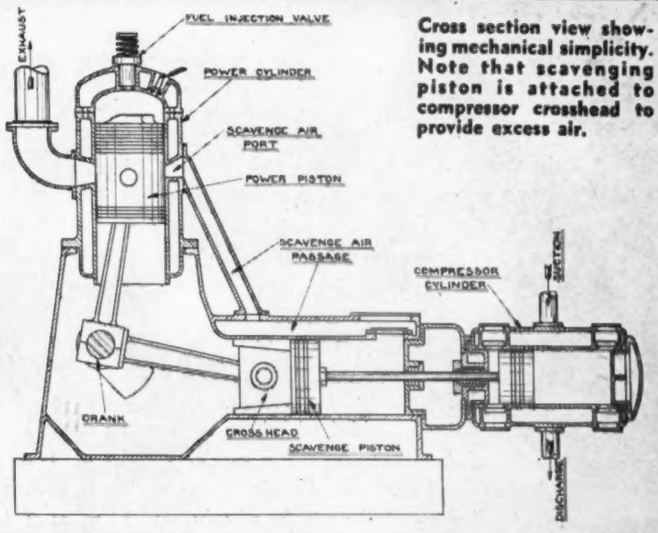
Union Oil Company
Universal Consolidated Oil Co.
Humble Oil & Ref. Co.
Standard Oil Co. of Ohio
Ohio Fuel Gas Co.
Eason Oil Company
Corpus Christi Refining Co.
Thatcher Glass Co.
M. W. Kellogg Co.



Cross section view showing mechanical simplicity. Note that scavenging piston is attached to compressor crosshead to provide excess air.

Clark Bros. Company, Olean, New York, U.S.A.
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CLARK

PROGRESS OF MAJOR PIPE LINE WORK

CONSTRUCTION is well underway on the oil pipe line being laid by the Shell Pipe Line Company from the San Joaquin Valley field of California to the Shell refinery at Martinez on San Francisco Bay. Total cost of the project is estimated at $4,500,000. Four sizes of pipe are being used, 6-in., 8-in., 10-in., and 12-inch. The main line will be of 10-in. pipe. Altogether 25,000 tons of pipe will be required, and the line will have a daily capacity of 25,000 barrels.

Pumping equipment installed will be of the most advanced type. The line will be operated at a pressure of 1000 lb. on that section between Bakersfield and Caliola, and at 800 lb. pressure on the section between Caliola and Martinez.

New pumping stations will be erected at Bakersfield, Wasco, Mid, and Kettleman. Existing stations at Caliola, Cheney, Merval, Stimba, Corral and Meganos will be completely re-equipped and made thoroughly up-to-date.

The line is being electrically-welded and the trunk system primed, given a hot coating, and wrapped with felt. Some rough territory is being traversed. In certain places on hillsides it is necessary to grade before ditching machines can be run. Pipe has to be dragged in with tractors in some locations, as the terrain is too rough for trucks.

●

A 40-mile pipe line outlet having a daily capacity of 5000 bbl. will be constructed by the Illinois Pipe Line Company, from the Lance Creek field of Wyoming. The line, which will be laid of 6-in. pipe, will run from Lusk, Wyoming, to Fort Laramie, tying into the system of the Stanolind Pipe Line Company at the latter point. Total cost of the project is estimated at $234,000.

No additional pumping stations will be required, since the one at the Lance Creek field has ample equipment to boost the crude to its destination.

●

The California Company is laying a 4¼-in. oil line from the Quealy Dome field to Rock River, Wyoming, a distance of 20 miles. The work has been contracted to Williams Brothers of Tulsa, Oklahoma, and their subsidiary, Haas, Inc., San Francisco, California. The line is expected to be completed the latter part of September.

●

The Tipton area of Jackson and Tillman counties, Oklahoma, is being provided with its first pipe line outlet by the Gulf Refining Company. The carrier will be of 4-in. and 6-in. pipe and will extend to Burkburnett, Texas, a distance of 45 miles. Ten miles will be of 6-in. and 35 miles of 4-in. pipe. The line is expected to be completed the latter part of September. Previously all oil from the Tipton area has been moved out by tank cars.

The Empire Companies have awarded a contract to the J. F. Pritchard Company of Kansas City, Missouri, for the laying of a 4-in. gasoline line from their new gasoline plant to Odessa, Texas, a distance of 14 miles. Two gathering lines also will be constructed, four miles of 5½-in., and four miles of 6-inch. The work is now well underway and all lines are being Lindewelded.

●

The Continental Oil Company will erect a booster station seven miles east of Edmond to handle the company's crude oil production from its wells in the Edmond field, it has been announced from headquarters at Ponca City, Oklahoma. The station will be situated at the end of a 10-mile pipe line that connects near Edmond with the Continental's Oklahoma City-Ponca City line. An 80,000-bbl. storage tank will be part of the construction.

●

A contract for a 10-mile, 6-in. pipe line has been awarded by the Kaw Pipe Line Company to Knupp and Son Construction Company, the line to be laid near Chase, Kansas. Construction will be by the stovepipe method of Lindewelding.

●

The Arkansas Pipe Line Company has announced plans for the construction of a gas line from the new gas fields in Bienville and Lincoln parishes to connect with the company's Monroe-Shreveport trunk line. J. G. O'Neal has been awarded the contract for the work.

●

Officials of the Crude Oil Pipe Line Company announce a pipe line will be laid from the Clara Driscoll field in Nueces County, Texas, to the company's terminal at Corpus Christi. The company already has a line from northern Duval County fields to Corpus Christi.

●

The White Deere Pipe Line Construction Company is the successful bidder on a line to be laid for the Phillips Petroleum Company. Approximately nine miles of various-sized pipe will be laid in connection with a natural gasoline plant to be erected near Edmond, Oklahoma. The line will be Lindewelded.

●

The Humble Oil and Refining Company has completed a 6-in. pipe line from Abilene, Texas, to the Hawley field in Jones County, a distance of 18 miles. The line has a daily capacity of 2290 barrels.

A CAMERON 3" CORE BARREL

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146' of the last 164' to

9963' at OLD OCEAN

- - - Recovery 85% to 90%

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Cameron is pardonably proud of the record of one of its 3-in. Type "C" Core Barrels on Harrison & Abercrombie's No. 1 Armstrong Fee at Old Ocean, Brazoria County. In this deep test, now preparing to complete at 9963 ft. in 30 ft. of sand, a 3-in. Cameron Barrel, *with regular 6⅛-in. soft formation core heads,* both drilled and cored 146 ft. of the last 164 ft. to total depth of 9963 feet. Despite the fact that the drilling report records alternate strata of "Hard Shale and Hard Sand"—which the cores themselves proved—the Cameron Barrel consistently averaged between 85 and 90 percent recovery. Considering the small size of the barrel, the great depth, and the extremely hard character of formations cored with soft formation core heads, this percentage of recovery stands as a very satisfactory record.

Numerous Gulf Coast operators today acknowledge, voluntarily, that the Cameron Type "C" Core Barrel is the most remarkable tool of its kind ever developed. Consistent recovery of 100 percent of the formations cored is by no means an exceptional report from them.

If you are not now satisfied that your investment in core barrel equipment, *and in coring time,* is producing the results to which you are entitled, we recommend a Cameron Barrel to you. Its fast cutting action; its design which eliminates necessity of delicate and particular handling while cutting a core and, above all, its unfailing ability to recover an exceedingly high percentage of all formations cut, will convince you that here is the barrel you have been waiting for!

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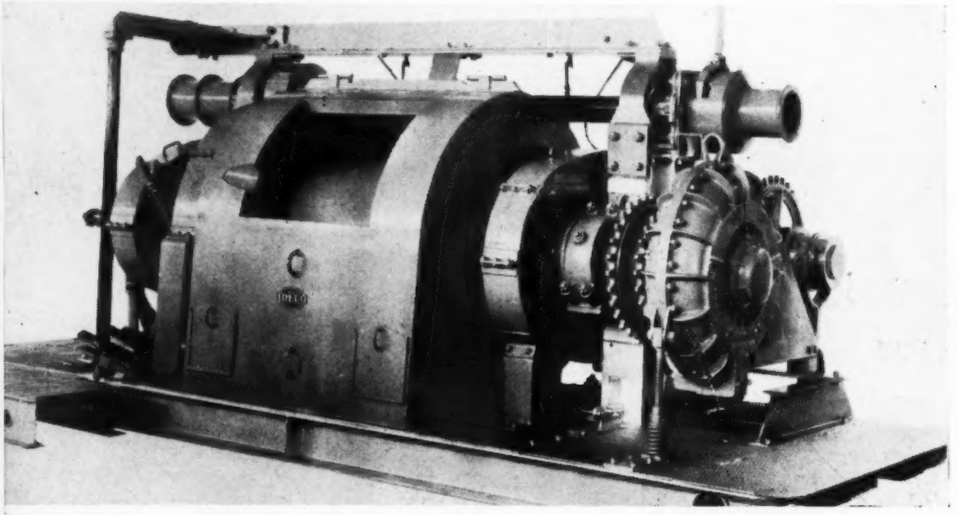
OKLAHOMA AND KANSAS: Carson Machine & Supply Company

Portable double-engine drive in which the prime movers are twin vertical steam engines with power take-offs to hoist, rotary, and slush pumps

Progress in Drilling



Modern unitized drawworks

ADHERENCE to the policy of conservative development of flush fields and holding production within the limits of probable demand have had a stabilizing effect on the industry. Conditions during the past year have been more stable than for several years. This has given operators an opportunity to concentrate more on improving their field practices, a sequel to which is the progress and trends in drilling and production methods that have been witnessed during the past year.

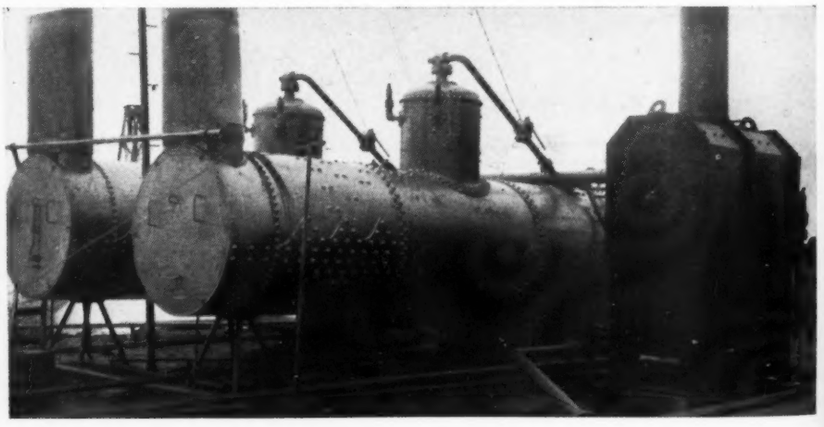
Drilling Practice

Among the important advancements to be noted in drilling practice are the improved methods of well completion. Wells completed under controlled pressure are enabled to produce oil and gas without interruption while drilling-in. Although developed several years ago, this practice is now coming into more general use. All wells in the northern extension of the Oklahoma City field have been completed in this manner. Although first adapted to wells in high-pressure areas, it now is found that the method is equally well adapted to low-pressure wells or wells in which the sand is very permeable. Where the reservoir pressure is low or the sand very permeable, close control of the pressure imposed by the circulating fluid on the face of the sand is essential. In drilling-in under controlled pressure the object is to maintain the pressure of the circulating fluid at the bottom of the hole sufficiently lower than the reservoir pressure that the flow of the oil or/and gas from the sand into the well will not be impeded. This is done by lightening the column of drilling fluid, either by the injection of gas into the circulation system at the surface or by using a lighter drilling fluid such as oil or water or a combination of both, and entails the use of some means of packing off the drill stem at the surface and also controlling the circulation returns from the well. Equipment of various types is employed for this purpose.

Besides reducing the hazard of a blow-out in high-pressure wells or of mudding off the sand in low-pressure wells, the productivity and other pertinent well data are observed as the sand is penetrated when drilling-in under controlled pressure. This information is utilized to great advantage in producing the well.

Controlled-pressure drilling has also rendered feasible the drilling-in of high-pressure gas wells with the rotary in the New York-Pennsylvania region.[1]

Several interesting developments in prime movers for drilling are observed. There is an increasing trend toward unitized power units. Facility in transporting and rigging-up is one requirement that modern drilling equipment, even the heaviest, must fill. To meet



Field boilers with superheater

Boiler feed pumps with feed water heater in which exhaust steam is used

By

K. C. SCLATER

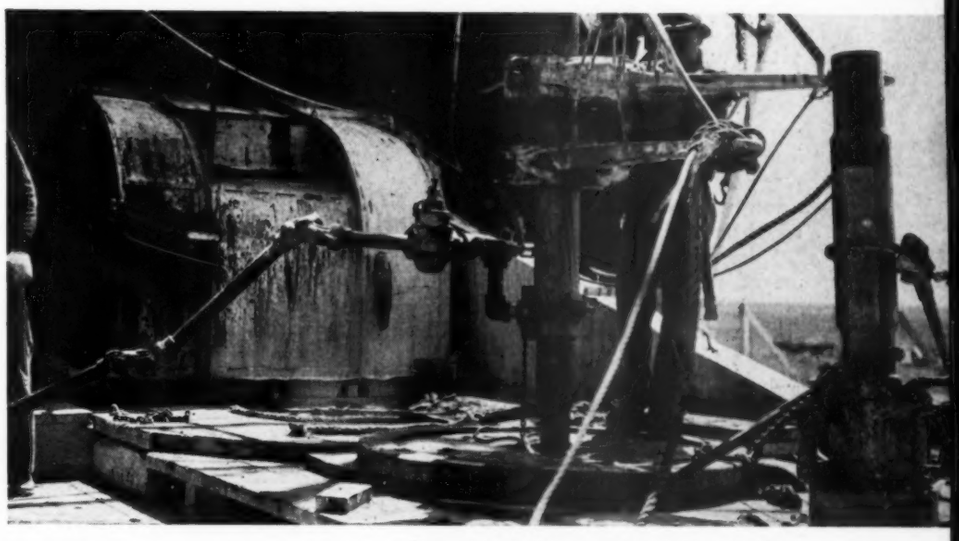
Well completion practice and secondary recovery methods show major improvement

and Production Methods

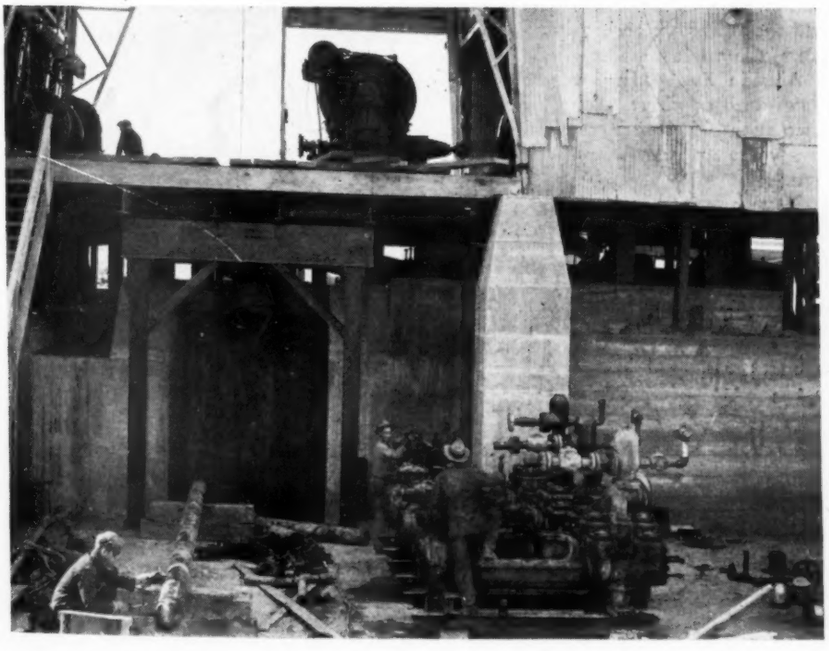
this need an opposed-piston type Diesel unitized power has been developed for deep drilling.[2] It develops d-c. power for drilling by the Ward Leonard system and consists of two units the engines of which each has a continuous rating of 225 hp. at 900 r.p.m., and 300 hp. at 1200 r.p.m. Each unit weighs 40,000 lb. and is mounted on steel skids. All accessories and auxiliary equipment are built into the unit to give compactness, portability, and completeness that will insure efficiency, flexibility, and low maintenance costs in operation.

Another interesting development in a power unit for heavy drilling is the direct-reversing Diesel.[3] This unit is direct-connected to the drawworks and has a 24-in. air-controlled power take-off clutch built into the flywheel. The speed of reversal is an advantageous feature of this power unit.

More efficient use of steam in modern deep-drilling operations is seen in the increasing trend toward superheaters. An interesting departure in steam power for drilling is the employment of three vertical twin-cylinder double-acting steam engines. One engine, a 12 by 12 by 12-in. stroke, drives the drawworks through a double-chain drive; another engine of the same size operates the slush pumps through a V-belt drive; and a third engine, 7¾ by 7¾ by 7-in. stroke, is direct-connected to the rotary and is set on the derrick floor.



For maintaining continuous circulation while drilling through heaving shale the 2-in. mud hose shown is hooked up to circulating joint and drill stem. In right foreground is the circulating joint connected to drill pipe in rathole



The cellar is a matter of considerable importance in controlled-pressure drilling. This one was in the process of construction on a well in the Lost Hills field, California

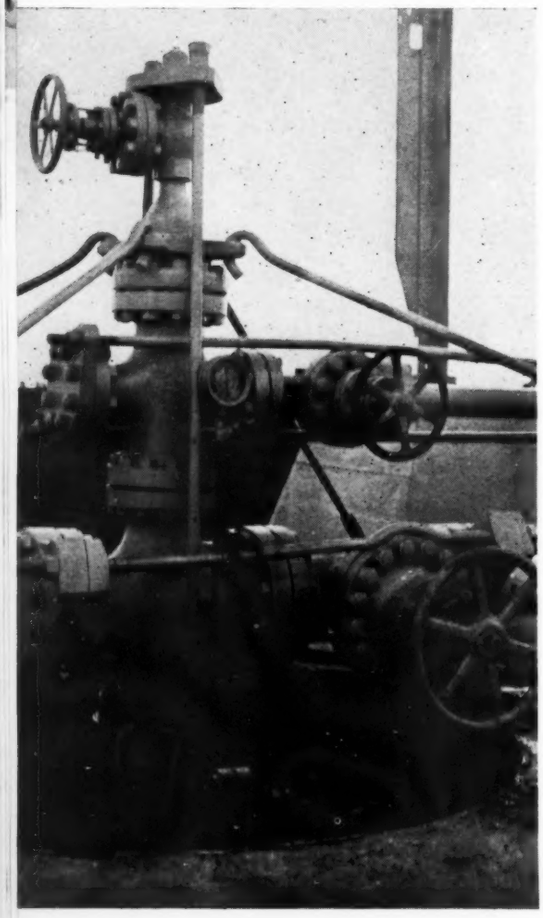
A portable steam drive recently developed and now in successful use consists of two 7¾ by 7-in. stroke vertical twin-cylinder double-acting steam engines. They are installed in line on a heavy structural steel frame and can be moved as a single portable unit that develops adequate power for medium heavy drilling. In normal operation one engine drives a power slush pump through a chain drive; the

A Hauser drive being used on a well in Fitts pool, Oklahoma, for drilling-in under controlled pressure

other engine drives the rotary table through the drilling hoist. When hoisting both engines are clutched together to operate in tandem for maximum power output.

A more efficient use of cement for shutting off water is that of injecting into the water sand under controlled pressure a thin cement slurry, which subsequently sets and becomes an integral part of the water sand.[4]

Special mechanical means and the use of sodium silicate drilling mud, have been successfully employed for drilling through great thicknesses of heaving shale.[5] Circulation was maintained continuously, even when adding drill pipe, by means of a special circulating joint; pulling of the drill pipe was obviated by using a wire-line drilling bit; and wetting of the shale by free water was prevented by having sodium silicate in the drilling mud. These three conditions were believed to be vital factors in preventing heaving of the shale.



High-pressure flanged Christmas tree on well in the Edmonds pool, Oklahoma. Actual gauge pressure on this well is 2475 pounds. Note the circular cellar

Production Practice

Restriction of production in flush wells to a fraction of their potential producing capacity has made its influence felt in the improvement of production methods in general. The producer has gradually come to think of his production in terms of ultimate recovery and lifting cost per barrel rather than just the number of barrels daily.

Difficulties encountered in pumping deep wells have caused many producers to ponder the benefits to be derived by conserving gas energy. Many different types of pumps are being tried out in an effort to overcome the extreme conditions encountered in deep wells.

One major company has recently developed a new type of pneumatic pump. It is of the displacement type and the valves are positively controlled from the surface.

Aids in analyzing well pumping conditions continue to be developed. Two such aids that have appeared recently are dynamometers of new design.[6, 7]

Secondary recovery processes receive more attention as time goes on. Both gas-repressuring and water-flooding operations are conducted on a more systematic and scientific basis than was the case only a few years ago. Coring and bottom-hole data are playing an increasingly important part in the operation and control of secondary-recovery projects.

A significant development in producing operations is the stabilization of the crude oil as soon as it comes from the well. This procedure is one that has been envisaged for some time by the far-sighted in the industry but difficult to put into practice because of diversified ownership of acreage in the field. Elsewhere in the issue is described a pioneer project for stabilizing the crude at the well in a flush high-pressure field.

There is an increasing trend toward drilling and producing methods that will conserve gas energy, the importance of which in increasing ultimate recovery and reducing lifting costs is now generally recognized.

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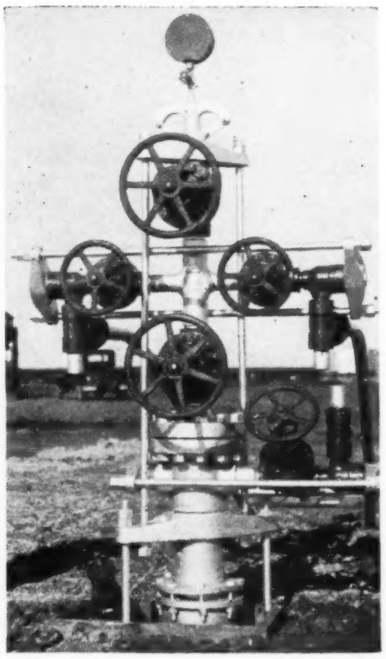
Christmas tree on high-pressure well in the Crescent pool, Oklahoma



Progress in Bottom-Hole Choking

By H. C. OTIS*

New Type Choke Developed for Controlling Flow of Gas Into Tubing When Flowing Weak Oil Wells

THE use of bottom-hole chokes to control rate of well flow from bottom or to plug tubing and casing strings temporarily for various purposes has become so general that only a brief review of the past year's developments is justified at this time. Besides briefly reviewing this phase of the subject there will be discussed in detail the possible application of a new type of removable bottom-hole choke for controlling the rate of gas admission into the tubing when flowing weak oil wells.

During the past year, approximately 150 high-pressure wells have been equipped with bottom-hole chokes to eliminate the freezing that otherwise would have taken place at the surface controls, and to simplify the regulating problem. Surface pressures have been as high as 3200 lb., while the depths at which the chokes were installed range from a few thousand feet down to much greater than 7000 feet. Most of these wells are in the Gulf Coast fields, although several of them are in the relatively new high-pressure areas of southern New York State and Pennsylvania.

The past year has seen a revival of attempts to lower gas-oil ratios by means of bottom-hole chokes. Not all these attempts have been successful. One such attempt, however, met with such marked success that the wells in the entire field in which the attempt was made are now equipped with bottom-hole chokes. The wells in this field (Peasel field, near Wellington, Kansas) are approximately 3400 ft. deep, and are equipped with 2-in. tubing. Bottom-hole pressures are somewhat less than 1000 pounds. Gas-oil ratios prior to the installation of bottom-hole chokes were approximately 10,000 cu. ft. per bbl., and these were reduced in several instances to 3500 cu. ft. per bbl. after the installation of the chokes. This is the first instance of all the operators in a field agreeing upon such a method of operation, a plan that has been recognized and approved by the State of Kansas. Experiments now are being started in a large field in Oklahoma to determine whether or not a

*Otis Pressure Control, Inc.

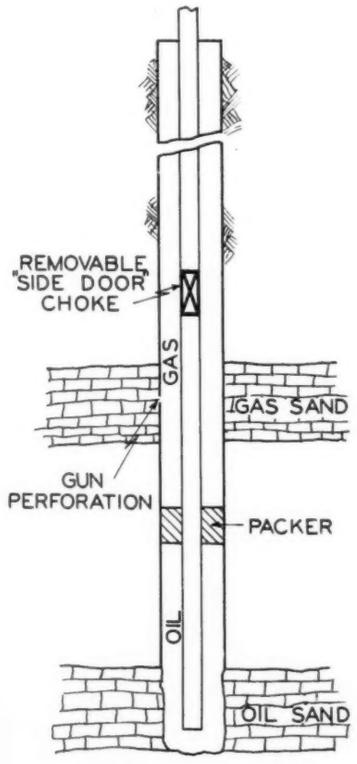


FIGURE 1

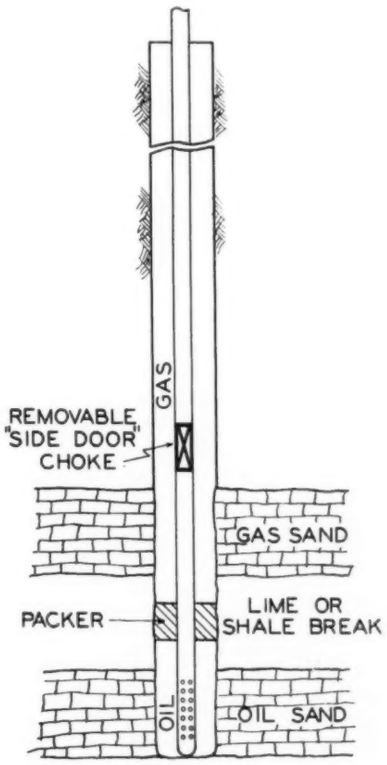


FIGURE 2

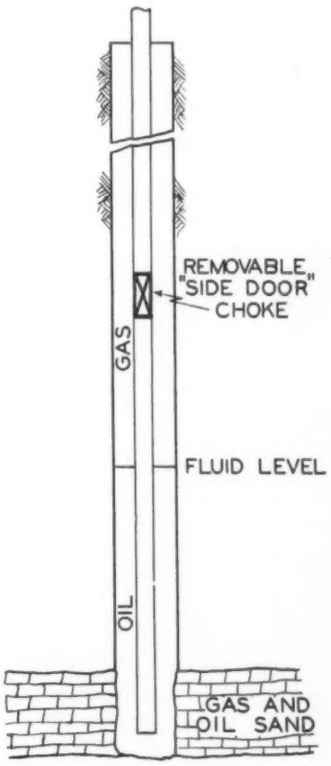


FIGURE 3

similar plan can be adopted successfully there.

Generally, however, it still appears that reasonable assurance of lowering ratios by this means can be had only when tubing flow velocities without the use of bottom-hole chokes are so low as to cause slippage — whether these low velocities result from high pressures and low rate of withdrawal or whether they result from an inadequate supply of gas—or when considerable heading is taking place.

The new type of bottom-hole choke referred to in the first paragraph has been more or less aptly described by one superintendent as a "side door" choke. The purpose of this choke, which can be run and pulled under pressure on a Halliburton line, is to permit the introduction, under control, into the tubing of gas from the annular space between the tubing and casing, while normally allowing unrestricted passage of oil from bottom. In effect, it might be compared to a removable jet collar, or to a jet collar that can be run into or pulled from a well on a Halliburton line to permit changing the jet diameter.

A simple example of a possible application of this "side door" choke lies in a well that has been gun-perforated into an upper gas sand to obtain additional gas to aid in flowing the well's oil production. Such perforating, whether or not done with the well loaded, may bring in far more gas than is necessary to maintain flow at the desired rate, with high gas-oil ratios as a result. The new choke would serve as a readily variable means of admitting only the desired amount of this gas into the tubing, at the same time ordinarily affording no material restriction to the flow of the oil. Another possible application would lie in those wells that employ a formation packer to separate oil and gas horizons, yet in which it is necessary to use some of the gas shut off by the packer. Still another posssible application would lie in a well of low bottom-hole pressure that has a large volume of free gas between the tubing and casing, and in which it is desired to utilize this gas for flowing the oil, without, however, disturbing the liquid seal in the well.

The above three possible applications are illustrated respectively in Figs. 1, 2, and 3. Fig. 4 shows the details of the choke construction: (1) represents a special landing nipple, which is made up in the tubing string at the desired depth and which contains the locking recess (2), the restriction (3), and the large openings (4). The choke, shown partly in cross-section, carries the three locking dogs (5) suspended from the carrier (6). The running tool is riveted to the mandrel at (7). The assembly is lubricated into the tubing and lowered under pressure on a Halliburton line and set of tubing jars to the landing nipple. While being run, the dogs are free to ride up the tapered mandrel to a retracted position, in which position they can pass into the locking recess in the landing nipple. The shoulder (8), encountering the shoulder (9), limits the downward travel of the assembly. When in this position, the slips will drop to their expanded position, in which position they will not pass restriction (3), so that the assembly cannot be blown up the tubing. Jarring upward will sheer the rivets that connect the running tool to the mandrel at (7), allowing for removing the running tool and line from the well.

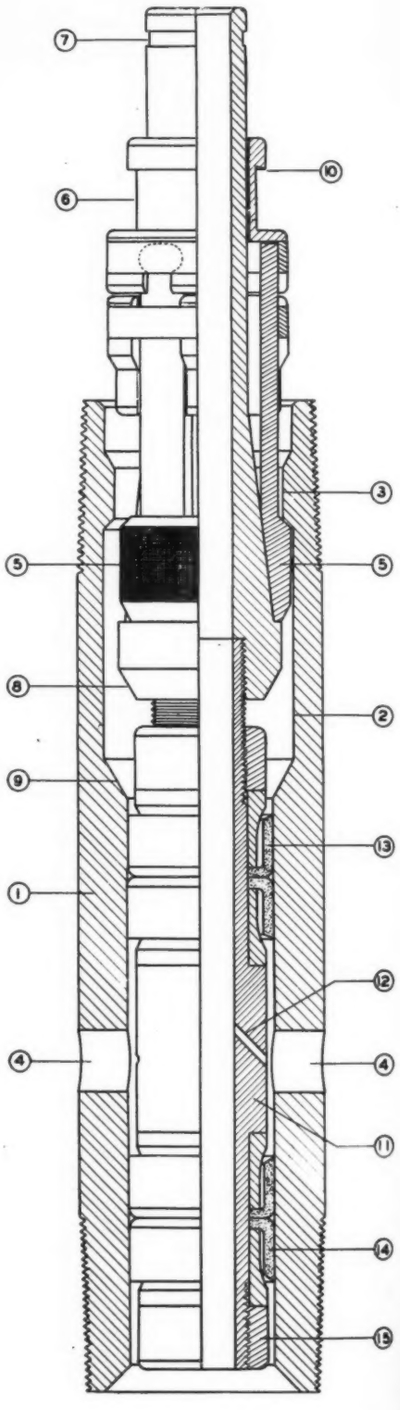
When pulling the choke, a pulling tool similar to that used in pulling removable chokes is run in until the dogs engage the shoulder (10) on the slip carrier. The weight of the jars will drive the choke downward until shoulder (8) meets shoulder (9). Picking up on the pulling tool will then pull the slips into their retracted position in which position they will pass freely through the restricted portion (3).

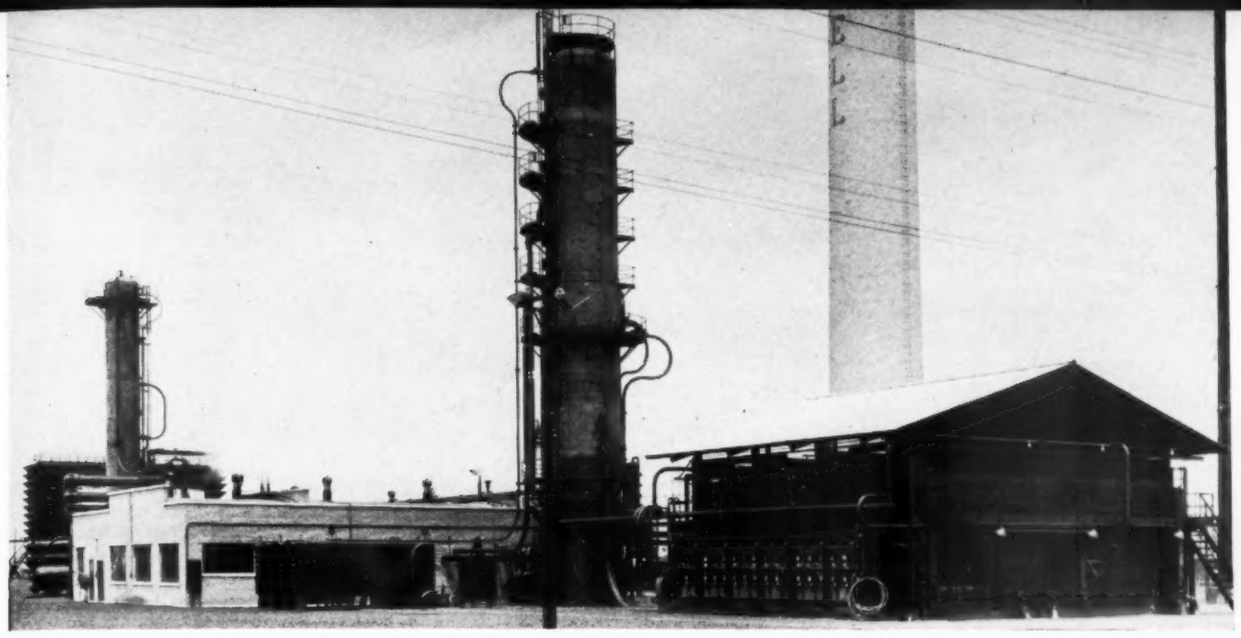
The parts that control the admission of gas from between the casing and tubing consist of nipple (11), which is drilled with the orifice (12), and the two sets of opposing cups (13) and (14). The orifice (12) is so spaced that when in the set position it is approximately opposite the large openings (4). Oil can flow freely up through the bore of the nipple (11). Gas entering the tubing through the openings (4) is prevented from flowing around the nipple (11) by the two sets of cups, but it can enter into the bore of (11) through the orifice (12). When varying the rate of gas admission, it is only necessary to pull the assembly, substitute a new nipple (11) with the desired orifice (12), and rerun.

If, when the well is closed in, there is the possibility of gas entering through (12) and back-feeding into the oil sand, a simple ball check can be substituted for the jam nut (15) or, if there is the possibility of oil feeding back into the gas horizon when the well is closed in, the large opening (4) may be equipped with a ball vertical check valve welded to the outside of the landing nipple. Under some conditions, such as severe heading, it may be advisable to equip also the lower end of the choke nipple with a bean, thus controlling independently the rate of entry of both gas and oil.

The size of the orifice, or orifices, employed, the depth at which the landing nipple is placed, etc., will of course depend upon relative pressures, life, desired rate of flow, etc. From an engineering point of view, future developments in the use of this or similar equipment should be quite interesting.

Fig. 4





Dubbs 10,000-bbl. unit for the reforming of gasoline

Progress in Refining, 1935-1936

W. L. NELSON, Refinery Consultant*

Engineering Improvements in Existing Practice Rather Than Development of New Processes Have Characterized Past Year's Developments

THE long expected upswing in refinery construction and development at last has become evident. The increase in activity was inevitable since new equipment rapidly is becoming a necessity in refineries due to obsolescence or destruction by corrosion. Most recent work involves either improvements and remodeling of old equipment or the installation of standard distillation equipment rather than the installation of new types of processing equipment, however, many new polymerization plants and dewaxing plants are being constructed or considered. Almost all refiners have adopted reforming processes in connection with their cracking equipment for the purpose of converting the excess stocks of low octane number gasoline into suitable motor fuel. During the year several companies have completed commercial polymerization plants and are marketing polymer gasoline blends. Polymerization may be considered as a further development of the cracking process. As an example, cracking was first practiced on gas oil and fuel oil for the formation of gasoline and cracked fuel oil or coke. About 1929 it became apparent that kerosene, blending naphtha, and even gasoline, could be decomposed, as in a cracking process, for improving the octane number of these stocks and still maintain the boiling-range of gasoline. In studying these operations, called "reforming," it was found that the yield of residue or cracked tar could be greatly influenced by the length of time that the material is exposed to cracking conditions. The polymerization processes are operated to take advantage of this phenomenon —in polymerization processes the physical conditions of time, temperature, and pressure are so regulated that a large residue of material having the boiling-range of gasoline is produced from the decomposition of gases. The same thing happens in cracking processes except that the conditions are selected so that a minimum amount of heavy residue material or cracked tar is produced. Thus gasoline is the polymerization product when decomposing gases, and cracked tar or coke is the polymerization product when decomposing gas oil.

As far as new major processes are concerned no outstanding ones have appeared and the year of 1935 must be classed as one noted for engineering improvements rather than the announcing of new processes.

Crude Oil Supplies

Although the production of crude oil has been curtailed during the year to aid in maintaining a proper market balance, nevertheless, concern over adequate supplies of oil for the future seems to be in evidence. Year by year new and larger oil fields are being found and developed, and constant progress is being made in the matter of obtaining oil from existing fields. Nevertheless, the demand continues to exceed the proven oil reserves and the day may not be far distant when crude oil will become a more valuable product than it is at present. In 1935 the production of motor fuel was approximately 450,000,000 bbl., greater than in any previous year including 1928. In 1936 a sharp increase is expected and a production of more than 500,000,000 bbl. is possible. As a comparison it may be recalled that only 260,000,000 bbl. were produced in 1925 and but 40,000,000 in 1915. Thus the production in 1935 was 60 percent greater than in 1925 and more than ten times as great as in 1915. In the past many of the large fields have been a source of dismay to the industry because of their size and effect on the market, but with the mounting demand as indicated, it is apparent that new large fields will be a necessity in the future rather than an excuse to glut the market.

Evidence of concern over the future sources of motor fuel are the increasing interest in high-speed Diesel engines, in natural gasoline, in polymer gasoline, and in alcohol fuels. Were it not for cracking and natural gasoline we already would be destitute for crude oil. One by one new sources of motor fuel become economical and are accepted by the industry. The talk of

*Professor of Petroleum Refining, University of Tulsa.

polymerization continued for years and now it is an accepted source of motor fuel. Likewise the subject of alcohol as a fuel has persisted for years. No doubt much of the interest at the present time is due to the dire predicament of the American farmer, but, in the writer's opinion, it may be a prelude to the extensive use of alcohol as a motor fuel. No matter how forcefully oil companies and technical men may decry the use of alcohol today, they are dubiously aware of the possibility that they may be glad to call for alcohol fuel during the next ten years. More oil probably will be found in the future than in the past, but the cost of production doubtless will rise to such a point that many substitute blending fluids will be feasible. A single large war would make great inroads on our proven oil reserves.

These signs of an increasing difficulty in meeting the demand for motor fuel are really good signs for the oil industry. A scarcity of crude oil would insure good crude prices and would require the refiner to conserve every barrel of oil. Even the adoption of high-speed Diesel engines for automotive use would be advantageous because it would permit him to finish a far larger percentage of each barrel of oil into valuable products. Even a small increase in the cost of gasoline would bring immediate development of the high-speed Diesel engine, the writer believes. The Pacific Freight Lines have studied the economics of Diesel truck operation with their fleet of 75 Diesel trucks and they find that the Diesel trucks save $25,000 per million truck miles. If the figures are comparable for passenger cars it would mean a saving of approximately $500 to $1,000 to the owner during the life of the vehicle.

Octane Number

The urgent demand for higher octane fuels, that became apparent about 1928 and has continued since that time, has been nearly met by the installation of additional cracking capacity, by the use of tetra-ethyl lead, by a more widespread use of natural gasoline, by the reforming of straight-distilled gasoline into cracked gasoline, and by polymerization. Reforming units are now considered to be standard equipment in connection with cracking plants; and polymerization plants are being considered by many companies.

Polymerization

Polymerization has been tested fully enough to permit a brief summary of the processes that are used and the results that are obtained. In all these processes the same general chemical reactions occur.

(1) The raw gas that usually consists largely of the unreactive paraffin hydrocarbons must be decomposed into other hydrocarbons that are unsaturated and chemically active.

(2) The chemically active hydrocarbons that are an intermediate material are combined together by the use of suitable physical conditions, often with the aid of a catalyst, to yield a material whose boiling-range is higher than the boiling-range of the parent gaseous stock. The octane number of the final product is so high that it may be used to blend with other fuels for the production of premium motor fuel.

The yield of polymer gasoline in some instances may exceed 15 gal. of gasoline per 1000 cu. ft. of gas or to exceed a conversion of 75 percent by weight. The process works most successfully on the larger gaseous molecules, such as butane and propane, although methods doubtless will be devised for more completely utilizing ethane and methane. Obviously feed-gases that already contain unsaturated gases such as butylene and propylene are the most suitable of all. Such gases are obtained from cracking processes, particularly the vapor-phase processes.

Judging from experience now at hand, the best operating conditions appear to be a relatively low pressure (150-250) and a high temperature (900-1100 deg. fahr.). The octane number of the polymer gasoline (without dilution) ranges from 80 to 120 by the C.F.R. Motor Method, depending upon operating conditions, the yield of gasoline, and the type of feed-gas. The polymerization plant is similar in most respects to a cracking plant: it consists of equipment for heating to a high temperature under a high pressure and means of maintaining these conditions for a suitable length of time. In many plants the gas is recycled just as recycle stock is circulated in a cracking plant. The gas supply in the United States is large enough for the production of over 200,000,000 bbl. of polymer gasoline.

Aviation Fuels

Although the manufacture of fuels has stayed abreast of automotive engine manufacture, Army engineers feel that still higher octane number would be advantageous for aviation fuels. An octane number of 100 by the special Army test method definitely improves engine performance and an octane number of 105 might be useful. Since 1931 the octane specification has stood at 87. Several substances have been suggested as blending agents, namely toluene, iso-octane, special hydrogenated gasolines, polymer gasoline, and of course moderate amounts of tetraethyl lead. Buc and Aldrin of the Standard Development Company suggest isopropyl ether.[1] This material is peculiar in that it has a low boiling-point and at the same time a relatively low vapor-pressure. The performance of this fuel when blended with gasoline to volumes of 40 percent is described in the paper by Messrs. Buc and Aldrin. Isopropyl ether may be produced from propylene, found in cracked gases, particularly in vapor-phase gases, and large quantities may be produced by the decomposition of the natural gas hydrocarbons as in polymerization processes. The cost of manufacture is reasonable and when used as a blending agent the very high octane number of 105 may be obtained with reasonable quantities of isopropyl ether. In all respects this material appears to be a suitable blending fuel.

Physical Data

The article by Egloff and Nelson, "The Modern Cracking Process"[2] should not be overlooked by technical men and designers. These authors and the research staff of the Universal Oil Products Company have extended the usefulness of the "characterization factor" that they introduced in 1933. This factor may be defined as the cube root of the absolute boiling-point in deg. fahr. divided by the specific gravity at 60 deg. fahrenheit. It is notable mainly because it serves as a means of distinguishing between the different bases of oils and even cracked or aromatic materials. Values of the characterization factor for typical stocks are as follows:

	Factor
Paraffin hydrocarbons	12.8
Paraffin base oils	12.5
Mixed base oils	11.8
Cracked materials	10.5
Asphalt base oils	10.2
Benzene	9.8

Such properties as molecular weight, viscosity (even at high temperatures), viscosity-index, critical temperature and pressure, thermal expansion, specific heat, latent heat, and general thermodynamic data, are correlated against the characterization factor. Heretofore, little physical data have been available and that which were available were mainly for mixed-base oils. By means of the characterization factor it is possible to see what effect the base of the oil will have on such important properties as molecular weight, viscosity, and the critical tem-

[1] "A New High Octane Blending Agent," by H. E. Buc and E. E. Aldrin, *Oil & Gas Journal*, June 18, 1936.

[2] "The Modern Cracking Process," by Gustav Egloff and Edwin F. Nelson, *Oil & Gas Journal*, July 2, 1936.

perature. Such data are not so spectacular as the announcement of new processes but fundamental physical data are the tools by which new processes are put into successful operation.

Miscellaneous Progress

During the year the use of inhibitors for delaying the formation of gum in cracked gasoline has increased greatly. Thus inhibitors are gradually replacing acid-treating and costly steam redistillation, although these operations cannot be dispensed with for certain gasolines.

The demand for special steels and alloy steels has continued to increase rapidly. In fact, the steel industry is undergoing a fundamental change in its methods of manufacture due to the large number of special and alloy steels that are now in demand by such industries as the petroleum industry, the automotive industry, and the chemical industry.

In pipestill or furnace design the Equiflux heater now used in connection with some of the Dubbs cracking plants is attracting attention. The unique feature of this heater is that the tubes, which are contained in the center of the still in a stack only a few rows deep, are heated by a large number of small burners arranged on both sides of the tube bank. This arrangement permits an exact control of the amount of heat that is absorbed by each sq. ft. of heating surface, either to get a mild and uniform rate throughout or perhaps of more interest, to maintain just the maximum rate of heating that each tube or section of tubes will withstand without danger of rupture or local overheating. The still may be constructed in a wide range of sizes but there are reports that some construction companies are planning to standardize on a single still, or perhaps two sizes of stills. By using these standard units of heater it will be possible to fill all jobs regardless of size by using several of them in a battery. This will greatly reduce the cost of engineering design provided a low-cost universally useful type of small still can be developed.

The installation of equipment for solvent-treating and solvent-dewaxing has continued during the year, although the bulk of the oil on the market is still manufactured by the standard methods. However, some technical difficulties still face the solvent refiners, one of which is the reported tendency of solvent-refined oils to cause engine corrosion. Those who are interested in a survey of the latest practice for the standard filter press method of dewaxing may refer to Bulletin 388 of the Bureau of Mines.[3]

Petroleum Chemical Industry

One of the features of the year is the great impetus received by what may be termed the petroleum chemical industry by the successful commercial operation of polymerization plants. Polymerization processes are important in themselves because they are a new source of excellent motor-fuel, but of even greater importance is the fact that the operations conducted in polymerization plants are an integral part of almost all synthetic chemical processes that utilize natural gas as a raw stock. In other words, almost all synthetic chemicals must be manufactured from unsaturated hydrocarbons, such as those produced during the decomposition stage of the polymerization process.

Vapor-phase cracking processes paved the way for polymerization by giving us experience in the very difficult art of heating gases to high temperatures, and now polymerization insures an enormous supply of those unsaturated hydrocarbons that must be available for many purely chemical manufacturing enterprises. Although many organic chemicals, such as the several alcohols, amylacetate, isopropyl and ethyl ether, formaldehyde, methanol, etc., have been made in the past or now could be made at a profit, these branches of the refining industry are as nothing compared with what may be expected now that polymerization has proven that a large and dependable supply of unsaturated hydrocarbons can be had. Commercial polymerization means that the first and primary step in almost every organic synthetic operation has been proven to be commercially successful. It is not inconceivable that in the future cracking processes will be conducted for the production of cracked gas rather than for gasoline—if these chemical branches of the industry should develop greatly.

The nitration of the paraffin hydrocarbons is a phase of organic chemistry that has received little attention. The authors Hass, Hodge, and Vanderbilt, describe the products of nitration,[4] and it appears that many commercial uses for these compounds may appear. The nitro paraffins are excellent solvents for resins and gums and even for pyroxylin lacquers when diluted with 1-butanol. Another use is the blending of Diesel fuel oils. The nitro compounds reduce the ignition temperature and thus may be used as primers. The nitro compounds also may prove of value in the solvent refining of lubricating oils.

The chemical products that may be derived from natural gas and cracked gas have been listed repeatedly but the developments now have become so impressive and the future is so promising that a list of a few of the possible derivatives is not out of place:

From Hydrogen
1. Ammonia
2. Methanol
3. Hydrogenated petroleum products

From Methane
4. Formaldehyde
5. Methanol
6. Methyl chloride (refrigerant)
7. Chloroform
8. Carbon tetrachloride
9. Nitromethane (solvent)

From Ethylene
10. Ethyl alcohol
11. Ethyl chloride

with chlorine
12. Ethylene dichloride
13. Ethylene chlorhydrin
14. Glycol diacetate (lacquer solvent)
15. Ethylene diamine (rubber manufacture)
16. Triethanol amine (organic base emulsifier)
17. Glycolnitrate (explosive)
18. Monoethyl ether (lacquer solvent)
19. Diethylene glycol (solvent)

and sulphur
20. Mustard gas

From Propylene
21. Isopropyl alcohol
22. Acetone (for explosives and tear gas)
23. Isopropyl ether (antiknock fuel)
24. Propylene glycol

From Butylene
25. Butadiene (synthetic rubber)
26. Butyl alcohols
27. Butyl esters

From Pentane
28. Amyl alcohol
29. Amyl chloride
30. Amyl acetate

Although only single compounds are mentioned in this partial list, many of these compounds are key materials that are used in the manufacture of many other organic derivatives. In the opinion of the writer the years 1935 to 1938 will be recorded as the real beginning of a petroleum chemical industry.

[3] "The Manufacture of Paraffin Wax from Petroleum," by Espach.—*U. S. Bureau of Mines Bulletin* 388. (Obtainable from the Superintendent of Documents, Washington, D. C., 15 cents per copy.)

[4] "Nitration of Gaseous Paraffins."—Industrial Engineering Chemistry, 28:339, March, 1936.

Recent Developments in Selective Solvent Extraction

By
R. S. FUSSTEIG

A CONTINUAL tendency exists in oil refining to develop methods that give a higher yield of the better products. In the early days of the development of this industry there was a demand only for burning oils and little or no demand for gasoline. Simple distillation with no fractionation was suitable for producing the latter materials.

The development of combustion engines and the growing demand for satisfactory fuel and lubricating oils encouraged competition that resulted in the installation of more efficient distilling methods and with it came dephlegmators, partial condensers, baffle towers, and other inefficient types of rectifying apparatus.

The shell still with its rectifying column was discarded for the tube still and fractionating column, which provided not only for the manufacture of products of higher quality, but also for increased yields; but even with the most efficient distilling apparatus it was found that impurities having the same boiling range cannot be removed.

In the early days of the development of refining burning oils, it became apparent that the treatment with concentrated sulphuric acid—used for the first time in England in the refining of coal tar in 1792—improved the quality of oils by removing these impurities; but this treatment resulted in chemical reactions, and being a strong polymerizing agent, attacked also valuable hydrocarbons, forming a sludge of little value.

To reduce the amount of chemical treatment, an attempt was made to improve the quality of lubricants by high-vacuum distillation. It was assumed that, since the residual fraction of crudes is invariably black and asphaltic, high-vacuum distillation would permit the production of lubricants not only of lower asphaltic content, but superior in quality as well. It is safe to say that high-vacuum distillation in the production of lubricating oils was responsible for producing oils having a lower carbon residue and requiring less chemical treatment; but also it is safe to say that it was impossible to remove entirely the asphaltic compounds from the oils by means of a high-vacuum distillation. Thus, the refining industry has displayed an increasing activity in the solvent refining field that has resulted in the development of several new solvent refining processes; but this idea was known for a long time as a theoretical process.

Much of the early work on the general subject of solvent refining was confined to the fractionation of the light oils into their separate constituents. Butleroff[1] was the first who carried out in 1870 a cold fractionation of hydrocarbon mixtures by means of solvents. Aisinman[2] effected a separation of heavy naphtha by means of dissolving in alcohol and fractionally precipitating by the addition of water. Charitchkoff[3] accomplished this separation by dissolving certain petroleum distillates in amylalcohol and fractionally precipitating by the addition of ethyl alcohol; but these methods presented only a theoretical value.

The earliest commercial application of solvent refining was the process discovered by L. Edeleanu for the refining of kerosene with sulphuric dioxide, and the reason for its selection primarily is the high selectivity of this solvent at low temperatures resulting in good separation between the desirable and undesirable hydrocarbons.

It was found by Edeleanu that liquid sulphur dioxide was effective in removing aromatics and sulphur compounds. This was a notable advance in the treatment of petroleum fractions, because it employed the principle of selective solubility and avoided the chemical reaction that accompanied treatment by sulphuric acid. It was found also that this operation not only was difficult because of low solubility, but that the product was little better than that produced by distillation and acid treatment.

Using the same principle of treatment as was introduced by Edeleanu for treating burning oils, numerous solvents were investigated as substitutes for sulphur dioxide. The search for improved solvents resulted in the adoption of nitrobenzene, furfural, acrolein, chlorex, etc., for the treatment of lubricating oil fractions. Many others also have been proposed, but most of these solvents are limited to the treatment of particular fractions from crudes of definite characteristics; for example, a solvent that is ineffective in lowering the carbon residue and in the removal of coloring material is limited to the treatment of distillates. The solvent that is ineffective for removal of sulphur must be used for the treatment of sweet stocks.

In general it is necessary to choose a solvent that will not dissolve to a high degree in the paraffinic hydrocarbons of the charging stock. For example, if this material will become saturated upon the addition of 20 percent of solvent, there will develop at this point the second or true solvent phase. In this latter phase there will become dissolved, provided the solution is a suitable one, certain portions of the original stock. As greater and greater amounts of solvents are added, the percentage of the original material dissolved will increase.

When the total of the solvent selected has been added and thoroughly mixed with the charging stock, and the mixture allowed to settle, these two phases may be separated one from the other by mechanical means, such as decantation. When this separation has been completed, there will be contained in one vessel the undissolved portion of the original material plus 20 percent of solvent. In the other vessel there will be the remaining portion of the solvent, together with such portions of the original stock as have proved to be soluble in it. If the solvent is removed from both of these separated phases, obviously there will be segregated portions of the original raw material in separate containers. If, then, the solvent has been properly chosen, i.e., it possesses the quality of "selectivity" to a high degree, these two fractions will differ considerably from each other; furthermore, the difference will be as follows:

The undissolved portion coming from the so-called oil phase will be constituted primarily of the more paraffinic materials that are originally present. The fraction produced by removal of the solvent from the true solvent phase will consist of materials highly naphthenic in nature or, in other words, of material of low hydrogen-carbon ratio, unsaturated compounds, hydrocarbon derivatives containing oxygen, nitrogen, and sulphur.

In general, when a raw hydrocarbon material is mixed with a solvent, and there results from this mixing a segregation into two phases, each phase of which contains both oil and solvent, it will be found that the above types

[1]M. A. Rakusin. Die Untersuchung des Erdoeles und seiner Produkte. 1906.
[2]Dinglers Polyt. J. 2. 297. 1892.
[3]Petr. Rew. Min., 1903. X.

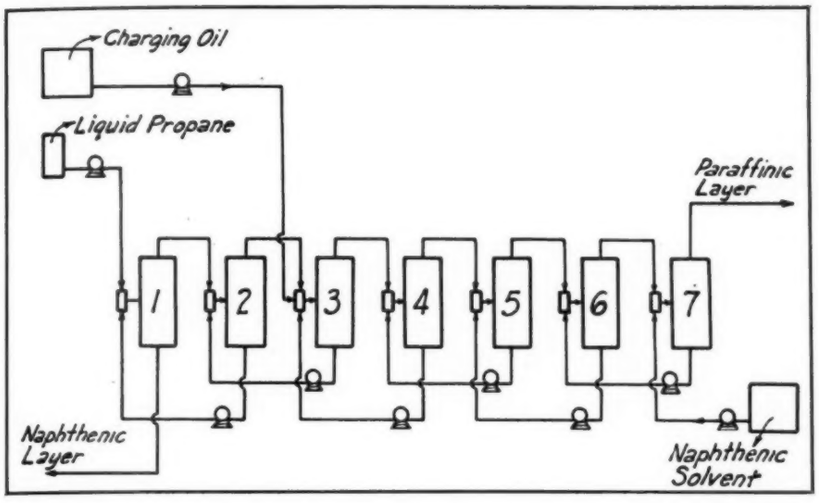


Fig. 1

of raffinate and extract will be produced; however, the degree to which the raffinate will be "paraffinic" and the extract "naphthenic" will depend upon that quality which we choose to call "selectivity." If the solvent chosen is highly selective, the difference between these two materials will be great. If the selectivity is poor, the difference will be small, and, obviously, we may say that intermediate degrees of selectivity may be measured according to the degree of difference between the two products that are produced. The selection of a solvent for refining depends upon many factors, the most important of which include:

(1) The solvent must possess much greater affinity for "naphthenic" material than the affinity the paraffin compounds, comprising the oil phase, will possess in order that comparatively small volumes of solvent will be required. This means that the distribution ratio of "naphthenic" matter between solvent and paraffinic compounds will be high.

(2) The solvent must possess low solvent power for "paraffinic" material, in order that the percentage of recovery of such material may be high.

(3) The solvent must be relatively insoluble in the paraffinic material. Obviously, such solvent as becomes dissolved in the oil phase will not be available for extraction from this phase.

Experience has shown, however, that employing a single solvent could not result in an economic selective refining of the lubricating oils. One of the very important features of this problem was the development of the Edeleanu system, which increased the degree of solvent power of liquid sulphur dioxide by the addition of benzol. By means of this innovation the most extreme and diversified types of oils of a wide range of activities and viscosities can be satisfactorily refined by using different proportions of the two solvents to satisfy the requirements both of high quality and high yields. The benzol has extraordinary solvent power for unsaturated, aromatic, resinous, sulphur-containing, and otherwise non-paraffinic compounds. Due to this discovery of the blending of benzol and sulphur dioxide in varying proportions, the Edeleanu process stood out as one having great scope of flexibility.

This method makes possible the treatment of gasoline or kerosene with sulphur dioxide, and lubricating oils with sulphur dioxide and benzol. Lighter oils normally require a more selective-solvent action than heavier oils to obtain results consistent with economical plant operation regarding yields, and with the two solvents, benzol and sulphur dioxide, the selectivity and the solvent power could be governed by different proportions of the two solvents.

Because of the flexibility of the benzol-sulphur dioxide combination, various types of distillates could be refined successfully by varying the production of benzol to sulphur dioxide and also by varying the total volume of solvent. In addition to the variations in quantity and ratio of solvents, the temperature also may be varied to meet certain conditions for treating only lubricating oils.

In considering the Edeleanu process in this connection it becomes apparent that even the use of solvent mixtures cannot be considered an ideal method of selective solvent extraction because they are selective only of the naphthenic fraction. Instead of employing a single solvent, or solvent mixture, that are selective of naphthenic oils, two solvents can be employed, one of which is selective for the paraffinic fraction of the oil charged and the other selective for the naphthenic fraction. Of course, solvents must be employed that have a limited solubility in each other, so that the solvents in themselves form a two-layer, solvent system. Such a system is provided to improve quality, flexibility and yield.

Such a system is the Duo-sol process. The basic principle of which is that propane as a paraffinic solvent may be used in conjunction with a naphthenic solvent.

In order to understand the reason for the flexibility of the double-solvent process, it is necessary to consider the extraction principle involved (Fig. I).

The double-solvent process provides an extraction system in which two liquid solvents are employed, each having a limited miscibility in the other, and one a selective solvent action for the more paraffinic crude fractions. Utilizing a double-solvent system necessitates the installation of separate recovery units for each solvent. This adds to the initial cost of the extraction plant, which is greater perhaps than in those cases where a single solvent is employed; however, the practical operation has established that regardless of the source of crude, whether high in wax, naphthenes, asphaltenes, or sulphur compounds, and regardless of the type of fraction, whether distillates or residuum, this process-treated oil has unusual stability, a low carbon residue, and, even from high sulphur stocks, a sulphur content too small to be measured.

A counterflow is established between the two solvents, and to them the raw stock is fed at an intermediate point. At the feed point the stock is selectively dissolved by the solvents, and equilibrium established between the paraffinic and naphthenic layers. Equilibrium at the feed results in an enrichment of the paraffinic layer by oil more paraffinic than the feed, and of the naphthenic layer by oil more naphthenic than the feed; but in each case the material dissolved is a mixture, and if the products were removed at this point the naphthenic layer would contain good paraffinic oil with resultant loss in yield, and the paraffinic layer would contain naphthenic material with resultant loss in quality.

To recover the paraffinic oil contained in the naphthenic layer, equilibrium is established in two successive stages between the outgoing naphthenic layer and the incoming propane. To remove naphthenic material contained in the paraffinic layer, four successive stages of equilibrium are established with the incoming naphthenic solvent.

Counting the feed stage, there are seven stages of contact and equilib-

rium, of which four are effective in rectifying the paraffinic layer and two effective in stripping the naphthenic layer. The rectifying section makes possible the production of oil of high quality, and the stripping section prevents loss of good oil.

In the selection of a naphthenic solvent to be used in conjunction with propane in the double-solvent process, it is necessary to consider a number of factors. The selectivity of this solvent for naphthenic oil should be increased by the presence of propane. It should have a limited miscibility with propane in the presence of oil. It should not only have a high solubility for non-paraffinic compounds, but also some solubility for paraffinic material. It should have a high specific gravity, so as to promote rapid separation between two layers. The critical-solution temperature should be in the range of 115-165 deg. fahr., so as to permit operation at normal temperatures and pressures. Its final boiling point should not exceed 425 deg. fahr., and it should have a low melting point, so as to avoid crystallization during extraction or storage, and, of course, it should be reasonable in price and available in large quantities.

To extract the naphthenic compounds in conjunction with propane, investigations of organic solvents indicate that cresylic acid most nearly meets the above requirements. Burstin[4] has established that even the single cresylic acid treatment produces high grade lubricating oils. But it also has been established a relatively high solubility for not only all the non-paraffinic hydrocarbons, but the paraffinic as well. With highly naphthenic oils, and with those of high specific gravity or high viscosity, separation is so poor as to make its use impractical. But when used in countercurrent with propane, it has a valuable characteristic, that is, its ability to take all the non-paraffinic compounds into solution. The little paraffinic hydrocarbons that also go into solution is of minor importance, since they are recovered by propane in the section.

Investigations of solvents have established that the simultaneous use of propane and cresylic acid improves the selectivity of extraction; for example, a Polish residuum when batch-treated with 300 percent cresylic acid produces a paraffinic layer of 75.20 percent, which is made up of 66.50 percent paraffinic oil and 8.70 percent naphthenic oil. When the same oil is treated with 300 percent cresylic acid and 300 percent propane a paraffinic layer is produced amounting to 84.0 percent, which contains 72.25 percent paraffinic oil and 11.75 percent naphthenic oil. It is thus shown that the yield by the single solvent method is 66.50 percent, while by the double-solvent method the yield is 72.25 percent; furthermore, it also is found that for oils of the same viscosity index the double solvent treated oil has a better color, a lower carbon residue, and a greater resistance to oxidation than the oil treated by the single solvent alone.

In handling waxy feed stocks it would, of course, be necessary to dewax it before treating it with these two solvents. The best economic method for this purpose is propane. Research works for several years have devoted considerable attention to the development of improved dewaxing methods in an attempt to develop a more flexible and less costly process.

In the course of these investigations it was found that propane offers excellent possibilities of accomplishing the desired aim, due to the following reasons:

(1) Solution of the wax-bearing oil in liquefied propane produces a homogeneous solution under pressure.

(2) Solution of the wax-bearing oil in liquefied propane would be very fluid and low in density to aid settling.

(3) Adiabatic evaporation of the part of propane produces a low temperature and crystallizes the wax.

(4) The great difference of the gravity between liquefied propane and solid paraffin-wax causes easy settling of the paraffin-wax.

Such a process should have the great advantage of self refrigeration instead of indirect heat transfer, should give solutions of low viscosity, and should permit the growth of large crystals; moreover, the presence of propane in the double-solvent process makes the dewaxing by means of this liquefied gas very economical. Hence the combination of dewaxing and refining of oils by means of propane has been established as one of marked commercial significance.

Thorough laboratory researches of the writer in the double-solvent process have established that its selectivity may be increased by addition of small quantities of phenol to the cresylic acid. The use of phenol for this purpose has been the writer's idea for several years.[5] He has found that phenol mixed with other solvents add to the selectivity between paraffinic and non-paraffinic compounds. By using the propane-cresylic acid-phenol, it has been found by thorough investigations of the writer that a better yield is obtained than with propane-cresylic acid. The same Polish residuum treated with 300 percent propane and 300 percent cresylic acid + phenol—a mixture of 98 parts cresylic acid with two parts phenol — produced a paraffinic layer amounting to 86.12 percent, which contained 74.33 percent paraffinic oils and 11.79 percent naphthenic oils.

Even these methods, however, do not present an ideal refining process, because of producing extracted oils containing great quantities of undesirable compounds. In the case of charging stocks of high viscosity the extract is oxidized to asphalt, and if the charging stocks are of low viscosity the extract is worked up by refining with concentrated sulphuric acid, thus caus-

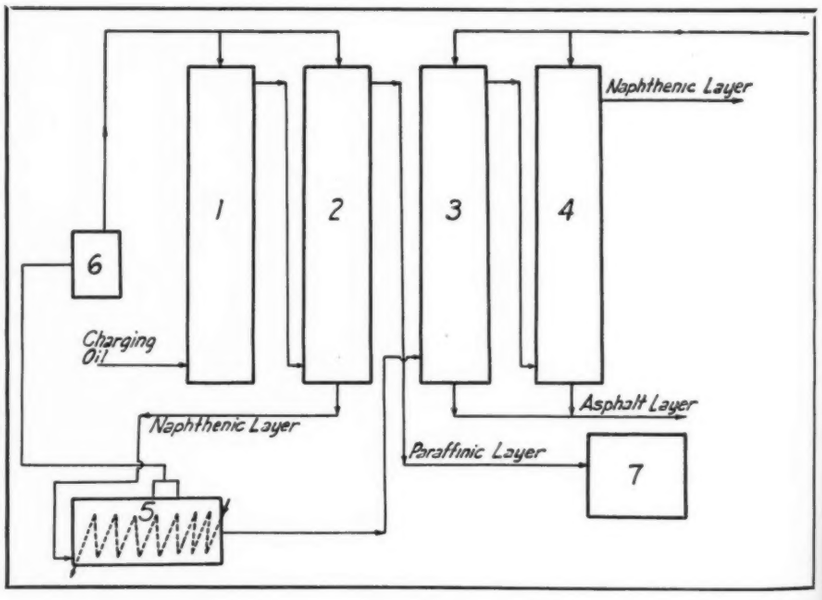


Fig. 2

[4]Petroleum. 1935. Nr. 15.
[5]Ztschrift f. an. Ch. R. Fussteig: eine neue Methode zur Bestimmung des Paraffins im Rohol. Vol. 91. Nr. 11, 12.

ing great losses in yield and producing a sludge of no value.

Kwal[6] has devoted considerable attention to selective refining of the second oil phase and after thorough researches he worked out a very interesting method, using for this purpose two solvents: phenol, to separate the paraffinic hydrocarbons from the charging oil, and alcohol m-nitrobenzylic, to separate the non-paraffinic hydrocarbons from the undesirable compounds. The apparatus used is shown in Fig. 2.

The apparatus consists of four vessels. The charging oil is pumped from a storage tank through the bottom in vessel I, and is extracted with phenol flowing counter-currently from the cooler VI. For the separation of the first phase the vessels I and II are used. The product of the first phase, Raffinate I, passes to the storage tank VII, while that of the second phase is charged to its still V. Phenol is here recovered from the second phase by distillation and condensed in the cooler VI. The dephenolyzed second phase oil is now pumped through the bottom in vessel III, and is extracted in countercurrent flow with the alcohol nitrobenzylic. In the vessel III and IV the non-paraffinic hydrocarbons are separated from the asphaltic compounds. The solution of asphalt-alcohol nitrobenzylic is discharged in a respective still to separate the asphalt from alcohol nitrobenzylic, while the refined second phase oil, Raffinate II, passes to a storage tank.

In the course of these investigations Kwal carried out studies on his proceedings; the first study being carried out on a Polish distillate having the following physical characteristics:

Specific gravity	0.928 at 15°C
Viscosity E°	12.1 at 20°C
Pour point	+1°C
Flash point	220°C

This oil was refined with phenol the first time in vessels I and II, to receive Raffinate I, which resulted in the following physical characteristics:

Specific gravity	0.895 at 15°C
Viscosity E°	6.9 at 50°C
Pour point	+5°C
Flash point	225°C

The second phase from this refining charge was then refined with alcohol nitrobenzylic in vessels III and IV, which resulted in a heavy naphthenic lubricating oil and asphalt of high quality. The physical characteristics of this naphthenic oil are as follows:

Specific gravity	0.952 at 15°C
Viscosity E at 100 C	2.3
Viscosity E at 50 C	21.5
Pour point	+5 C
Flash point	225 C

This refining experiment resulted in the following yield:

Raffinate I containing aliphatic compounds	62.0 percent
Raffinate II containing naphthenic compounds	34.0 percent
Asphalt	4.0 percent
	100.0 percent

The second experiment was carried out on a Polish residuum, from the crude of Boryslaw. The characteristics of this residuum were as follows:

Specific gravity	0.952 at 15°C
Viscosity E at 50 C	8.1
Pour point	+1
Flash point	282 C

The following table shows how well these solvents satisfy the requirements previously mentioned. The produced oils are of high-grade quality; furthermore, this process results in a maximum yield.

	Raffinate I	Raffinate II	Asphalt
Yield	70.0%	26.0%	4.0%
Specific gravity	0.895 at 15	0.936 at 15	1.05 at 15
Viscosity E	2.9 at 100	3.2 at 100	
Pour point	+11	+16	
Flash point	278 C	294 C	

Conclusions

In this article is shown the progress in the refining of lubricating oils. A great many methods have been proposed in different patents, but there is no proceeding published that treats on the selective refining of the second phase oil. Treatment with phenol and alcohol nitrobenzolic offers a means of selective decomposition into raffinate I and II, and asphalt without losses. Therefore, this new idea is very important from the standpoint of economy and technology of the refining industry.

[6]Revue de Chimie Industrielle, 1935. Nr. 526, p. 282.

Method of Determining Inflow Characteristics of Panhandle Gas Wells

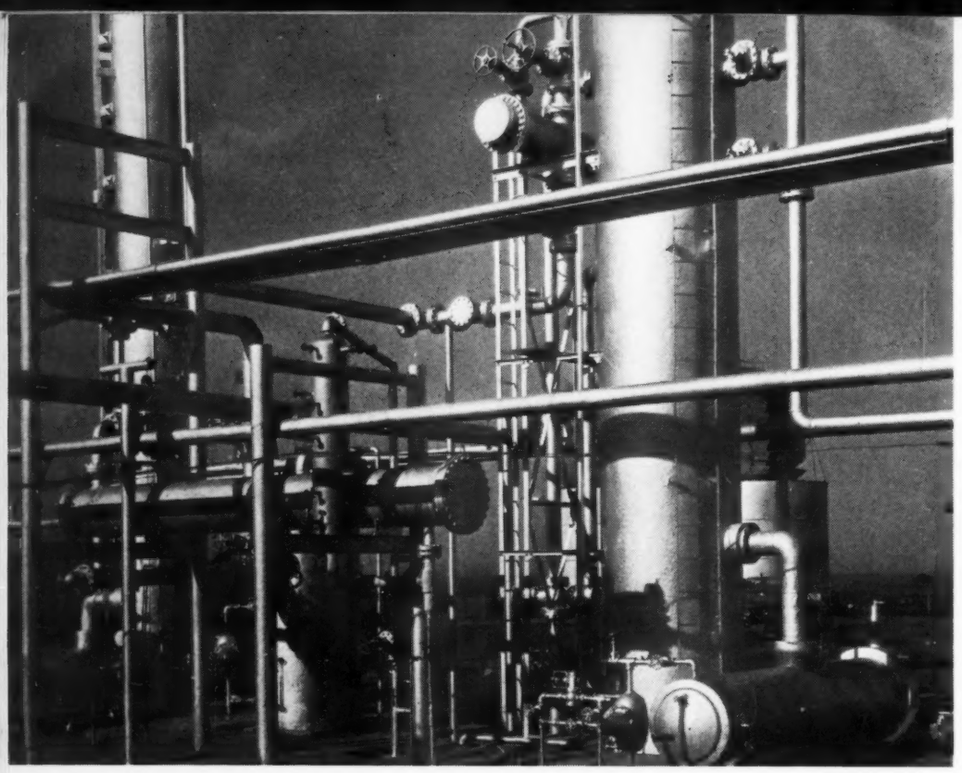
A METHOD of determining intake capacities under different well-head pressures from data descriptive of the "output" or producing characteristics of the wells has been developed by the United States Bureau of Mines, Department of the Interior. A recently issued report gives the results of tests to determine the output and input characteristics of six natural gas wells in different parts of the Texas Panhandle field that were made available for study through the cooperation of a number of producing companies.

Operators in the Panhandle area of Texas have been confronted with the problem of handling supplies of gas above ground that were in excess of market requirements, and proposals have been made to return this excess gas to the reservoir. However, information regarding the intake capacities of gas well systems was meager, and in projects involving the flow of gas into porous rock reservoirs, costly trial and error methods were necessary to determine intake capacities of the gas wells.

In order that the return of gas to the formations might be accomplished on a better engineering basis, output characteristics of the six gas wells under test were determined in accordance with the Bureau's method of using back-pressure data, described in Bureau of Mines Monograph Seven, published a few months ago in cooperation with the Natural Gas Department, American Gas Association. Tests of the intake characteristics of the six natural gas wells described in the present report were made for comparison under similar conditions of pressure and flow stabilization, and rates of delivery into the well were plotted on logarithmic paper against corresponding values of the square of the delivery pressure at the face of the sand minus the square of the formation pressure. The slopes of the two lines representing the output and input characteristics of a well generally were approximately the same. The output delivery rates generally were 4 to 7½ percent greater than the rates at which gas was delivered into the respective wells.

The close relationship of well characteristics that has been determined furnishes a means of calculating the gas delivery into a well based upon outflow data, provided the shut-in formation pressure is known. This method should provide a means whereby operators will be able to plan gas-injection programs more effectually to conserve natural-gas resources.

Report of Investigation 3303, "Comparison of Output and Intake Characteristics of Natural Gas Wells in the Texas Panhandle Field," by M. A. Schellhardt and E. L. Rawlins, may be obtained without cost upon application to the Information Division, U. S. Bureau of Mines, Washington, D. C.



The large column to the right is a gas fractionator in one of the Skelly Oil Company's plants. The horizontal exchanger is part of butane expander apparatus for lowering temperature of gas leaving the top of the fractionator to 40 deg. fahr. for condensing desired quantities of propane for reflux for column

●

Manufacture of natural gasoline has undergone many revolutionary changes since the early days of the industry. The writer here discusses some of the recent developments

Progress in Natural Gasoline Extraction

By J. W. VAIDEN, Superintendent of Gasoline Plants, Skelly Oil Company

NATURAL gasoline in the early days was manufactured almost exclusively by the compression process. The compression method has little ability to select the desirable components from the undesirable components of casinghead gas. The resultant product in the early days, regardless of characteristics, was sold in the raw state. Approximately 15 times the present value of 26-lb. R.V.P. gasoline was received for the material. Accordingly, it is not difficult to realize that large losses of the product were not viewed with great concern by those in charge of the plants. Company balance sheets were showing nice profits and everybody was happy; however, those happy days were short-lived. The purchaser soon realized that large amounts of the material were being lost at his refinery. Naturally, specifications were soon devised with the intention of causing the manufacturer to produce a more stable product for sale. This marked the advent of special specifications, requiring application of new physical chemistry laws to both the design and the operation of equipment to meet the imposed specifications, and also to give better operating efficiency partly to compensate for the downward trend in price of the product. The part played by partial pressure as affecting vaporization in liquid mixture was soon realized and the industry turned directly to fractionation. The present almost standard bubble-cap column, usually operated between 175 and 200-lb. gauge pressure in manufacturing 26-lb. natural gasoline from raw gasoline, was then developed.

Gas Fractionating

The industry now is applying fractionation directly to natural gas in the recovery of natural gasoline. A brief description of the process is as follows:

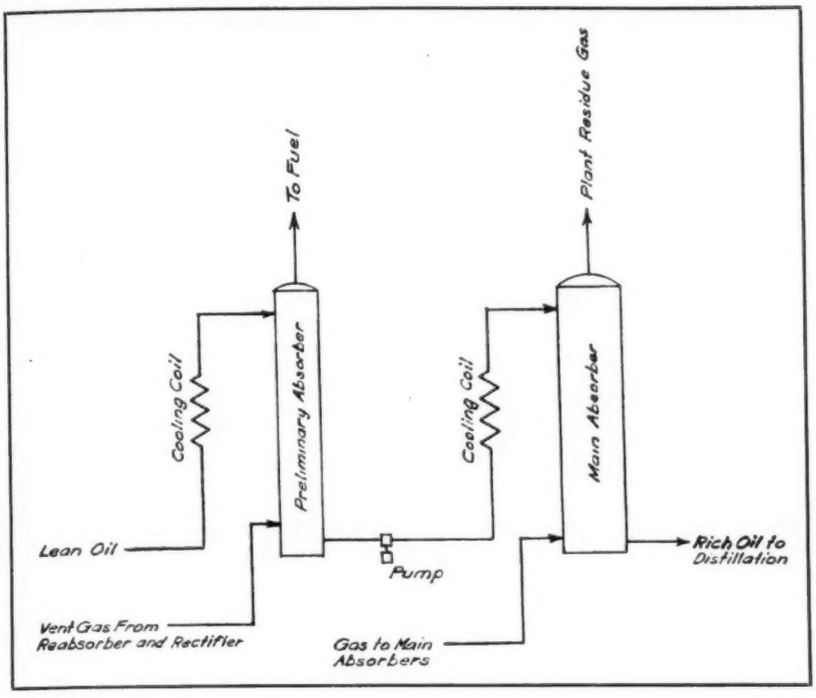
As early as 1930 the first successful installation of a vapor-rectification plant was completed in the Mid-Continent. The vapor-rectification process, patented by Petroleum Engineering, Inc., since has become a popular type plant for both the recovery of gasoline from natural gas and for the recovery of gasoline from uncondensed refinery vapors. This type plant is adaptable to gas of relatively high percentages of butanes and propanes to the heavier hydrocarbons.

The process briefly comprises the introduction of gas and vapors into a column, and rectifying the mixture in it by eliminating the lighter hydrocarbons from the butanes and heavier fractions by simple fractionation. In this process the heat of compression of the gas entering the column is utilized for the reduction of heat input into the reboiler for the evaporation of reflux. The elimination of the absorption step reduces the amount of cooling and heating load for the cooling and heating of the absorption oil, thus reducing the amount of utilities per gallon of gasoline produced.

In general, it is estimated that approximately 50 percent of the utilities is saved by the operation of a vapor-rectification plant, as compared with the operation of an absorption plant, for a similar degree of recovery of gasoline. Its extraction efficiency also is greater than that which can be obtained in an absorption plant, due to the fact that it is possible to obtain a recovery of 100 percent pentanes and heavier, while a recovery of 98 percent of pentanes and heavier is considered excellent for an absorption plant.

Propanes and Butanes

The sale of propanes and butanes has advanced to such a degree that several



Process for lowering oil rates

of the larger manufacturers of natural gasoline have installed additional equipment at their plants to extract larger percentages of these components of casinghead gas. The propanes and butanes are included in the regular raw make and are separated by fractionation. Marketing of propane for use in household appliances in the Minnesota area requires a propane product of almost C. P. specification due to subzero weather encountered during winter months. The propane product must be entirely free from mechanically entrained or dissolved water to prevent clogging of pressure-reducing regulators by the freezing of water. The Cobalt test is used to detect water in propane and butane and it is said that the test will detect a spoonful of water in a carload of either product. To meet such rigid specifications requires field men trained in the operation of highly specialized equipment and thoroughly familiar with the characteristics of the pure hydrocarbons.

C. P. Hydrocarbons and Intermediate Boiling Range Cuts

Another use that natural gasoline plants are making of the fractionating column is that of separating pentanes, hexanes, heptanes, octanes, and several intermediate boiling range mixtures for use in solvent, C. P., and other highly specialized trades. The design of equipment for this work is practically the same as the regular plant fractionator with variations in the size of columns, number of trays, space of trays, down spout area, and the control of reflux and operating pressures and temperatures. While the possibilities for new outlets for hydrocarbon cuts at present are limited, it is expected that new uses for these cuts will become more and more important as time goes on.

Lowering Oil Rates

One of the latest advancements in the manufacture of natural gasoline is the process of lowering oil rates by saturating absorption oil with the vent gases at the plant. A patent has been applied for by the Fluor Corporation covering this process.

In this process as much of the vent gases as possible are absorbed by the lean oil before entering the main absorber and this heat of absorption removed prior to this "enriched" lean oil entering the main absorber. The relative pressures of the main absorber and the preliminary absorber and the oil circulation will determine the amount of gases not absorbed.

In high-pressure pipe line plants, it has been found that the residue gas from the preliminary absorber, when operating this absorber at a pressure of 58 lb. gauge, consisted only of methane and ethane, while in low-pressure plants, it may be possible to re-absorb all these vent gases into the lean oil.

Some of the advantages of this process are: the temperature rise of the oil in the main absorber is greatly reduced, thereby permitting a reduction in oil rate. This "enriched" lean oil contains more mols per gal. than the original lean oil and the change in number of liquid mols passing through the absorber is reduced. This results in a higher average number of liquid mols in the absorber, thereby greatly improving absorption. The addition of these light constituents to the oil reduces the partial vapor-pressure of the pentanes and heavier left in the oil by the still, thereby giving higher extraction efficiency in the absorber.

The temperature of the oil on the top plates of the absorber is reduced. The relatively high temperature of the oil on the top plates is due largely to the absorption of methane, ethane, and propane. If the oil already contains a large volume of these constituents, very little, if any, absorption of these constituents takes place in the top of the absorber. The lower the temperature of the oil on the top plate, the lower the partial vapor-pressure of the desirable constituents.

In pipe line plants, this process permits the return of all or most of the vent gases to the line without the use of a recompressor.

Gasoline plants in general have not added any revolutionary principles to their method of manufacture during the past year. The greatest advancement has been made in simplifying design to eliminate excess equipment at one time thought necessary for efficient operation. Someone once said, "good engineering is the application of common sense to known engineering principles." This, the writer believes, describes the advancement made in natural gasoline manufacture during the last few years.

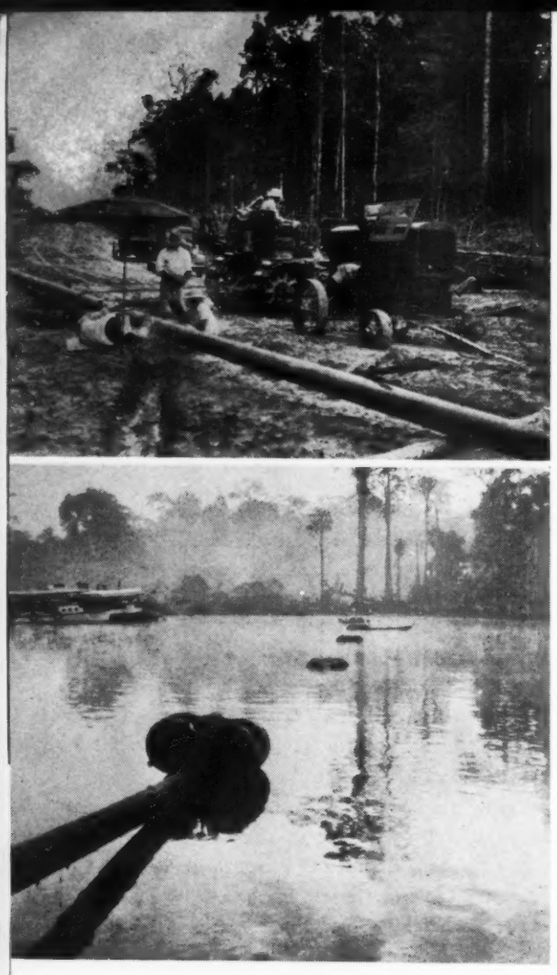


Fig. 1. Construction scenes on an 8-in. pipe line, Netherlands India, 1935

Progress in Electric-Welding of Pipe Lines

By A. F. DAVIS*

Developments in arc-welding methods featured by a new simplified joint

THE greatest forward step in the electric-welding of oil pipe lines during the past year has been the extended use of plain butt joints without backing-up ring on the straight-end pipe. This type of joint, replacing the double-bell joint made with backing-up ring, is the simplest possible type of joint for pipe line construction. It is now used widely in the arc-welding of oil pipe lines.

During the period from January 1st, 1935, to the present time many miles of lines have been constructed under all sorts of conditions by use of plain butt joints. Particulars regarding some of the more important of these lines are given in Table 1. Accompanying illustrations show some of these lines under construction.

*Vice-President, The Lincoln Electric Company, Cleveland, Ohio.

The Plain Butt Joint

The plain butt joint without backing-up ring is illustrated diagrammatically in the sketch, Fig. 3. As shown, the pipe ends, which have been bevelled (usually to 30 deg.), are lined up with a space of about 1/16 in. between them and tack-welded together. The tack welds are usually between one and two inches long and two or three of them are used per joint, depending on the size pipe. The tacking is done with ¼-in. or 5/16-in. electrodes. Following tack-welding, the actual welding of the joint begins. This is done in three beads, or passes, as the pipe is turned. Each bead is cleaned before application of the next. The first, or stringer bead, is made with 3/16-in. electrode. The size electrode used for the second bead is ¼-in. or 5/16-in., depending on the pipe size. Either 5/16-in. or ⅜-in. rods are used for the third, or finish, bead.

Standard procedure for constructing pipe lines by arc-welding, utilizing plain butt joints without backing-up rings, is highly efficient.

The pipe, which previously has been spotted by trucks along the site of the line, is placed on rollers in sections. The length of the section depends on the terrain.

After the pipe is lined up and clamped (see Fig. 2), each joint is tack-welded so that the entire section can be turned easily during the welding. Tacking is done by one operator and a welding machine that moves along the right-of-way with the line-up gang.

Following tacking comes the firing-

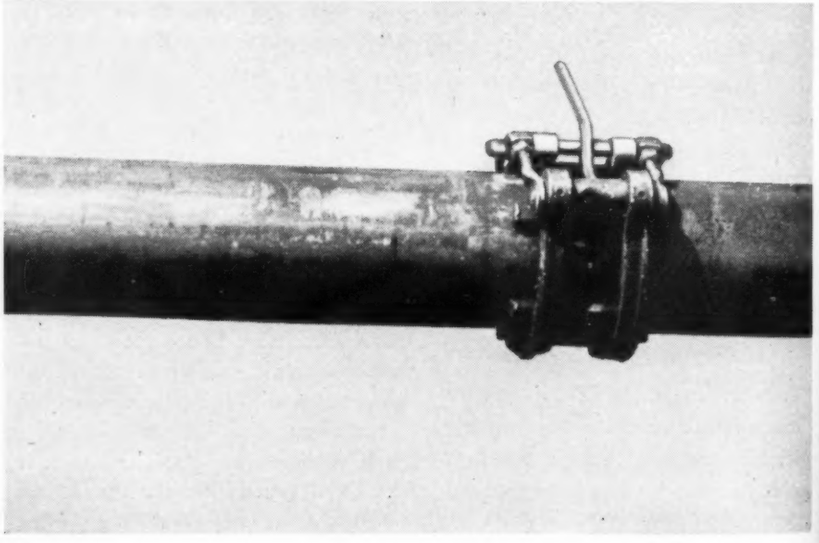


Fig. 2. Clamp holding pipe in line for tacking butt joint without backing-up ring

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TABLE 1

SOME OIL PIPE LINES BUILT BY ARC-WELDING SINCE JANUARY 1, 1935
(Utilizing Plain Butt Joints Without Backing-Up Ring on Straight-End Pipe)

Owning Company	Length of Line (Miles)	Dia. of Pipe (in.)	Location of Line
Phillips Petroleum Co.	4	4″	Near Sunray, Texas
Phillips Petroleum Co.	6	6″	Near Sunray, Texas
Phillips Petroleum Co.	20	6″	McPherson, Kansas
Cimarron Pipe Line Co.	116	6″	Enid, Okla. to Hutchinson, Kansas.
Panhandle Eastern Pipe Line Co.	8	6″	Lees Summit, Mo., to Wilmington, Ill.
Continental Oil Co.	44	6″	Lake Charles to Jennings, La.
Phillips Petroleum Co.	3½	8″	Oklahoma City, Okla.
Stanolind Pipe Line Co.	28	8″	Near Ada and Meeker, Okla.
Panhandle Eastern Pipe Line Co.	16	8″	Lees Summit to Kansas City, Mo.
Standard Oil Co. of Calif.	9	8″	Bakersfield, Calif.
Continental Oil Co.	44	8″	Lake Charles to Jennings, La.
Phillips Petroleum Co.	10	8″	Sunray, Texas
Stanolind Pipe Line Co.	93	10″ and 12″	Freeman, Mo., to Wilmington, Ill.
Phillips Petroleum Co.	1½	12″	Fairfax, Okla.
Standard Oil Co. of Calif.	5	12″	Bakersfield, Calif.
Shell Pipe Line Co.	8	8″	Near Midland, Texas
Liberty Pipe Line Co.	154	8″	From Rusk, Tex., to Conroe, Tex.
Fredell Construction Co.	33	8″	From McAllen to Port Isabel, Tex.
Gulf Pipe Line Co.	28	8″	From Beaumont, Tex., to near Orange Field
Shell Pipe Line Co.	48	10″	From Jal, N. M., to Midland, Texas

TABLE 2

ELECTRODE SIZES FOR ARC-WELDING PLAIN BUTT JOINTS
Without Backing-Up Ring

Dia. of Pipe	SIZE OF ELECTRODE		
	Stringer Bead	Second Bead	Finish Bead
4 in.	5/32″ - 1/4″	1/4″	1/4″ - 5/16″
6 in.	5/32″ - 1/4″	1/4″ - 5/16″	5/16″
8 in.	5/32″ - 1/4″	5/16″ - 3/8″	5/16″ - 1/4″
10 in.	5/32″ - 1/4″	5/16″ - 1/4″	5/16″ - 5/16″
12 in.	5/32″ - 1/4″	5/16″	3/8″
14 in.	5/32″ - 1/4″	5/16″	3/8″

line welding gang, consisting of one or two arc-welding operators, the same number of arc-welding machines, and one or two helpers. One helper turns the pipe as an operator welds. The second helper cleans each bead before application of the next.

Fig. 4. Making a weld on the 180-mile gasoline pipe line constructed by the Keystone Pipe Line Company in 1935

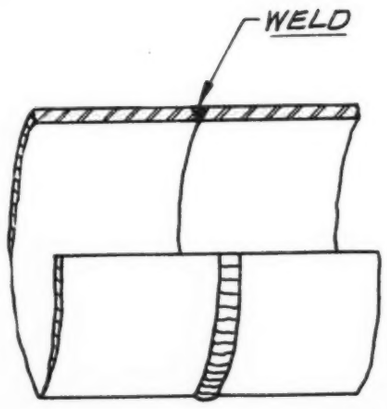

Fig. 3. Diagrammatic sketch showing details of plain butt joint on straight-end pipe without backing-up ring

Table 2 gives particulars on sizes of electrode and currents used for welding the three beads used on plain butt joints without backing-up ring.

Fig. 5 shows the number of pounds of electrodes necessary to weld plain butt joints in various sizes of pipe. The figures given allow for 15 percent waste for stub ends of electrodes, and may vary slightly with weather conditions and the skill of the operator, but with average conditions and good operators the values are accurate.

The electrode used widely in electric pipe line welding is the heavily-coated shielded-arc type. This electrode provides welds having the following physical properties: Tensile strength 65,000-75,000 lb. per sq. in.; ductility 20-30 percent elongation in 2 in.; impact resistance 30-70 ft-lb. (Izod); fatigue resistance of 28,000-32,000 lb. per sq. in.; density of 7.84-7.86 grams per c.c.; resistance to corrosion greater than mild steel.

The speeds for welding various sizes of plain butt joints without backing-up rings are shown in Fig. 6. The chart gives the speeds made in welding 4-in., 6-in., 8-in., 10-in., and 12-in. pipe, the sizes most widely used in

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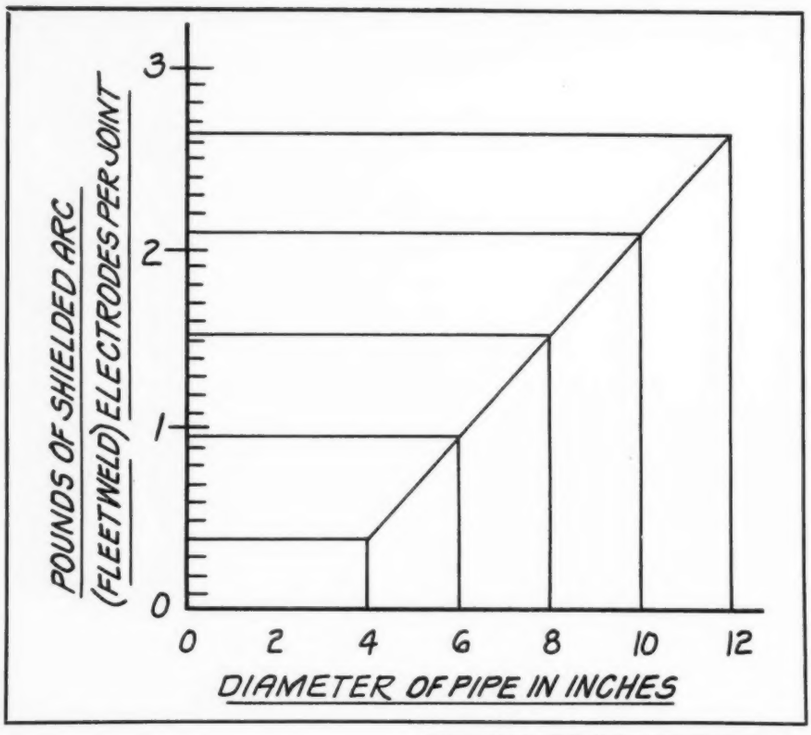


Fig. 5. Chart showing number pounds of electrodes per joint in various sizes of pipe for oil lines. Note that number of pounds increases in direct proportion to size of pipe

oil line construction. Larger sizes, 14 in. and 16 in., using plain butt joints without backing-up ring, have been welded at the rate of 30 and 26 joints, respectively, per man per nine-hour day. The speeds shown in the chart are conservative and apply to welding under generally favorable conditions and include waiting time. That the speeds are conservative is indicated by the fact that they have been exceeded on many lines. The 190-mile 8-in. line of the Independent Oil and Gas Company from Corsicana to Conroe, Texas, was welded at the average rate of 60 welds per man per 10-hour day. Approximately 28,000 ft. of 6-in., 8-in., and 10-in. lines were welded at the same rate for a refinery.

Sections of line, welded up in the manner here described, are tied into the line by bell-hole welds. Tie-in welds are generally welded in three or more beads.

Following bell-hole welding, the section of line is placed in the ditch. Part of the section, consisting usually of nine joints, is placed in the ditch and back-filled to hold slack, leaving three joints out of the ditch on skids. The part on skids usually is left until sometime between 2 and 6 a. m. (when contraction is maximum) at which time it is put into the ditch and covered. This procedure prevents excessive contraction of the line after the ditch is back-filled.

In making river crossings, the pipe is welded up in a section long enough to span the river. The section might measure as much as 500 ft. in length. When the section is welded, and the ditch in the river bottom dynamited or dredged or dug by jetting as in the case of quicksand to a minimum depth

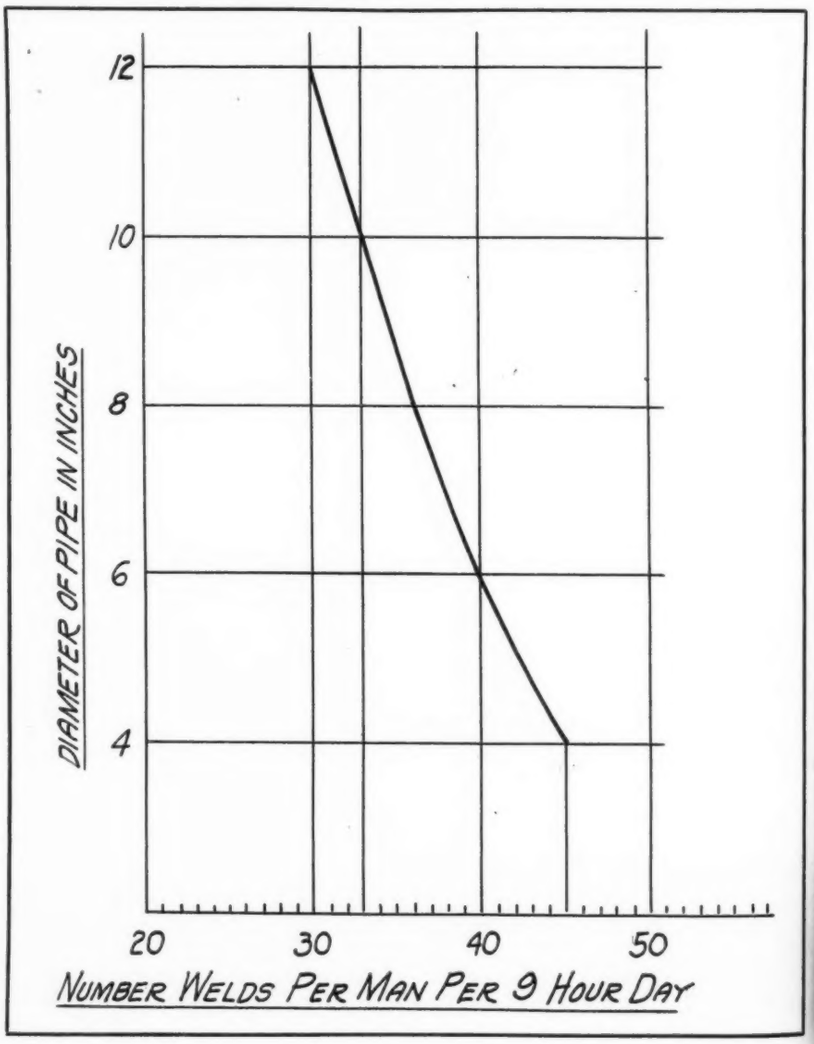
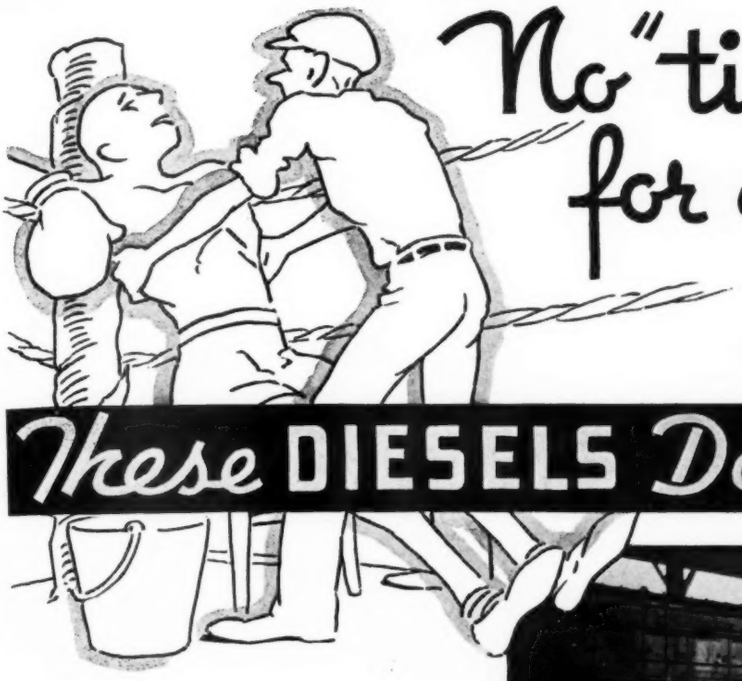
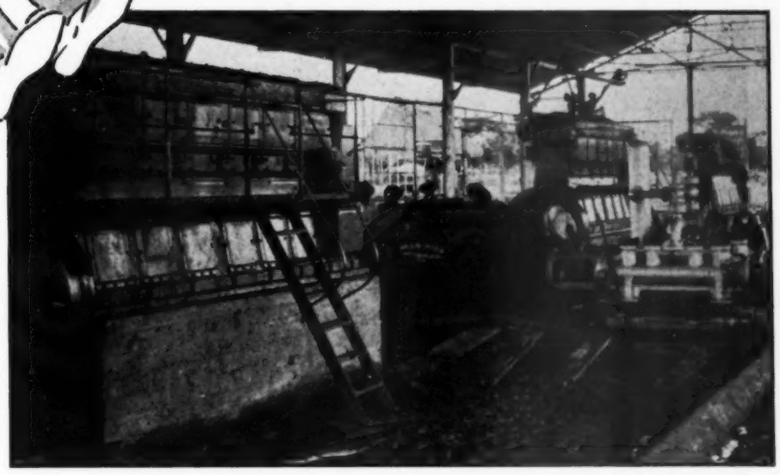


Fig. 6. Conservative pipe-welding speeds per man per 9-hour day on straight-end pipe without backing-up ring



No "time out" for a "breathing spell"

These DIESELS Don't Need it!

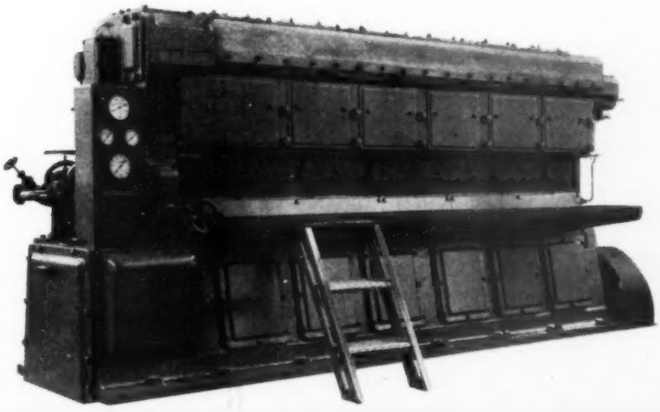


Down in Mexico they needed a half-dozen Diesels to power two new booster stations on an oil pipe line between Posa Rica and the loading docks at La Barra. The service is HARD — the engines must be on the load 24 hours a day, continuously.

That's exactly the kind of work that Type JT Diesels are cut out for. Their husky parts don't need a "rest" — and never need to be coddled. The Anglo-Mexican Petroleum Corporation gave Type JT's the job — as the photograph shows.

Cooper-Bessemer builds a complete line of Diesels for every kind of oil-field service. Let our representative tell you about their Convenience, Reliability, and Economy.

ABOVE — Three Type JT-6 Cooper-Bessemer Diesels being installed in one of the two new booster stations of Anglo-Mexican Petroleum Corp. Each of the six engines is rated 315 H. P. at 328 r. p. m., and will direct-drive Wilson-Snyder reciprocating oil pumps.



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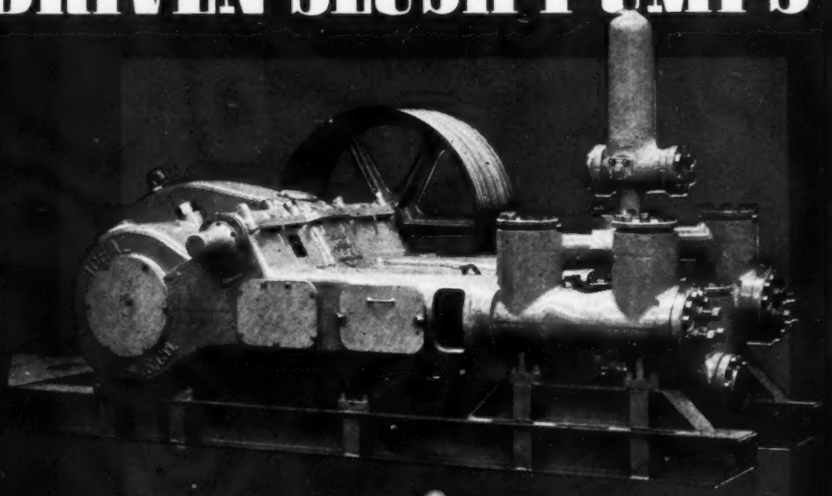
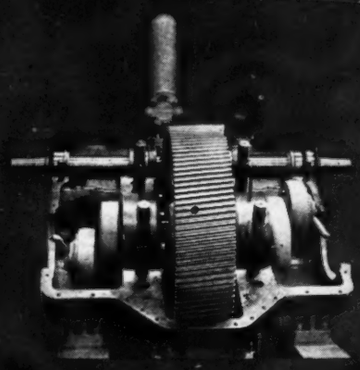
Bulletins descriptive of these pumps are available upon request.





Model No.	Maximum Liner Size	Stroke	Maximum Working Pressure	Rated Speed	Rated H. P.	Weight
C150	6¾	12	2000	65	150	17000
C250	7¼	15	2500	60	250	28975
C350	7¾	18	3000	55	350	36400

THE NATIONAL SUPPLY COMPANY

NSCO
REG. U. S. PAT. OFF.

Fig. 7. Repairing corroded pipe by welding. Magnolia Pipe Line Company's reconditioning project

of eight ft. below bottom at mean low level, the section is attached by cable to tractors on the opposite bank and pulled (and pushed by another tractor on the first bank) onto pontoons from which the section is guided to the bottom by stakes.

To hold the pipe in place beneath the bottom of a river, special river clamps are used. These clamps are four ft. to ten ft. in length, weigh 1000 to 3000 lb. each, and are bolted to the pipe and buried beneath the river bottom. From six to nine clamps are employed on an average 200-ft. crossing. The actual number depends on river currents, etc. Bell-hole welds tie the river section into the line at either side of the river.

New Joint Permits Large Savings

The savings in pipe line construction costs through use of plain butt joints arc-welded without backing-up rings are large. The former type of joint, the double bell with backing-up ring, was more costly for two principal reasons. In the first place the pipe ends had to be belled. The cost of double belling was approximately $1.50 per ton of pipe. Backing-up rings cost 25 cents to 35 cents each. Thus, the cost per joint including the belling of the ends and the chill band, in the case of the double-bell joint, was $1.50 to $2.25, depending upon the size. This expense is eliminated when plain butt joints are used, since no belling or backing-up ring are needed.

Arc-welding has advanced to its present status in pipe line work due to steady improvement in shielded arc-welding equipment. Modern shielded arc-welding machines and electrodes make it possible for pipe line contractors to produce pipe joints 20 percent to 50 percent higher in tensile strength than those made by former arc-welding equipment. In addition to obtaining these high-quality welds, pipe line contractors today are welding pipe at remarkably high speeds. Welding speed, with certain shielded-arc equipment, exceeds the former process by as much as 200 per cent. The 1936 pipe line welder is as far ahead of its predecessor in performance as it is in appearance.

Two recent pipe line arc-welding developments are worthy of mention. One is a remote control device that effects savings of hundreds of dollars per year per welder.

A special idling device developed and perfected is saving 35 percent or more in fuel consumption on pipe line welding machines. This device slows down the engine of gasoline-engine-driven welders when the arc is broken, and, at the same time, affords the operator 30 seconds' time in which to change electrodes.

Reduced Cost of Pipe Welding

The net result of the tremendous strides that have been made in arc-welding in the past year or so is a remarkable reduction in pipe line welding costs.

Pipe Line Maintenance

Of value in pipe line construction, the electric arc is also a pipe line maintenance tool. The electric arc's speed and flexibility has made possible a reduction of 50 to 90 percent in cost of pipe line repairs.

The shielded arc is regularly used in welding patches over pitted areas of pipe. In some instances, where corrosion has pitted a large section of pipe, the electric arc fuses in a new section, frequently without shutting down the line. The process also is used in repairing leaky couplings, split sleeves, and joints. Branch connections are easily welded to existing lines.

Acknowledgement

The author wishes to make acknowledgment to H. C. Price, Inc., Bartlesville, Oklahoma, and Big Three Welding Equipment Company, 1717 East Presidio Street, Fort Worth, Texas, for their help in the preparation of these data.

Fig. 1

New procedure evolved by one pipe line company proves to be effective and highly economical

By
L. A. ELLIS

Leak Reconditioning on Large Diameter Gas Lines

ECONOMY of maintenance is of primary importance to all companies, and to one whose major investment is buried in the ground where it means an expense whenever it is uncovered for inspection, economic methods assume a position of major importance, and every effort must be made to prevent a repetition of effort and expense at any one spot.

Much thought has been given this subject by the Houston Pipe Line Company, and it was found that one source of wasted effort was the repeated uncovering of highly-corrosive spots due to new leaks appearing where the pipe previously had been uncovered for leak repair.

Fig. 1 illustrates the nearness of such leaks one to another and shows a joint of 18-in. pipe on which have been installed 13 leak clamps. The joint was removed from service in a high-pressure gas line when inspection showed about a mile of pipe in this same area had become so badly corroded that the officials of the company were afraid it might come apart, and the cost of leak repairs had arrived at such a point as to be comparable with the cost of relaying the line.

It was decided to try to find some effective means of reconditioning a small area of large diameter pipe that was uncovered each time a leak was repaired and to observe the results over a period of two or more years. This decision was arrived at because it was noted from the leak report records that repairs were made quite often on the same joint in the line within a period of from 30 to 60 consecutive days. Investigation revealed that the reason seems to lie in the electro-chemical action set up between the pipe and the clamp placed on it to repair a leak. It is general practice with gas transmission companies, as well as distributing companies, to place a rubber disk or a piece of rubber packing over the hole in the pipe and then draw down on the bolts of the clamp until the leak has been shut off. This means that the clamp is in contact electrically with one side of the pipe and insulated from the other side. Potentials as high as .2 volt have been measured on partially buried lines between this insulated side and the pipe itself. This is caused by the clamp generally being of a class of steel different from the pipe itself, and a difference of potential is set up at this point. Accordingly, it was decided to apply a coating to this spot, which would thoroughly insulate the clamp from the pipe immediately adjacent to it, as well as coat the clamp itself.

In searching for such a coating, the following factors had to be borne in mind:

1. Coating must have high electrical resistance and maintain it under extremely wet conditions, which inevitably prevail where corrosion leaks occur.

2. It must be a hot application with a quick set-up time, since long drying time of cold applications is impossible in the limited time allowed for leak repair.

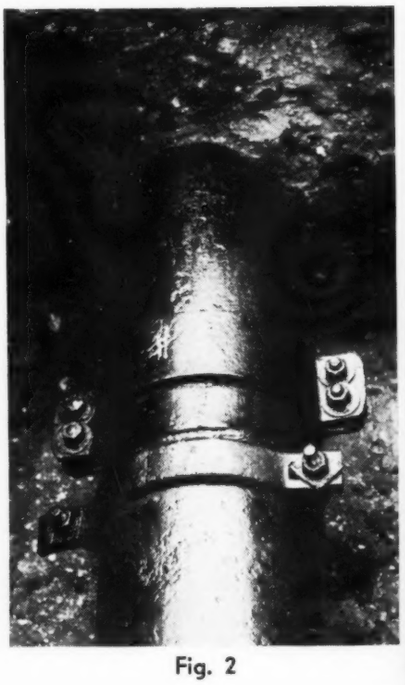


Fig. 2

3. Since it seemed impractical to run a holiday detector to examine pipe for pinholes in the coating at every leak, the coating used must be as free as possible from these in order to be effective.

4. As this was all an experiment to start with, the coating had to be

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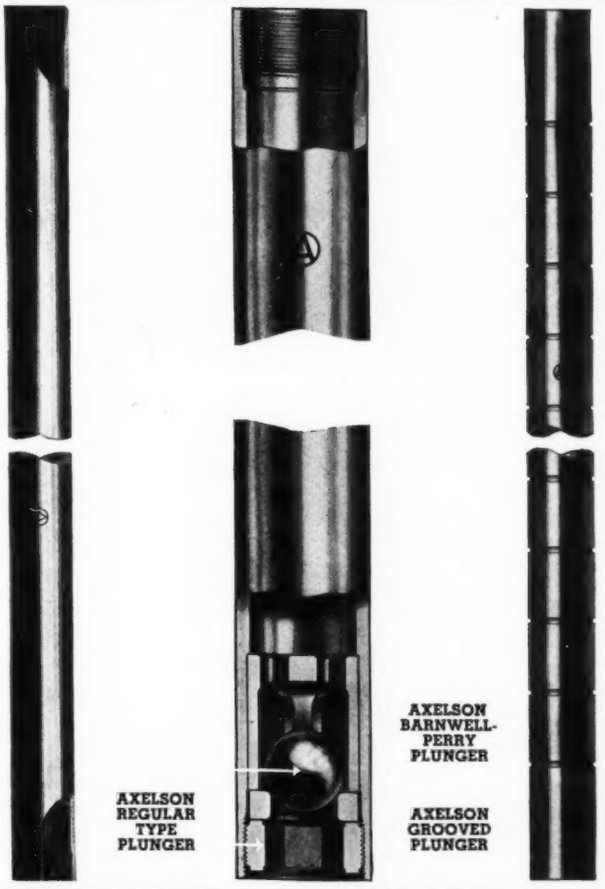

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Five standard types of liners are all furnished in plain or belled, one or both ends, as desired. Each type of liner has been designed to meet various conditions of a specific pump, for instance—all five standard types are available for either tubing Liner Pumps or Rod Insert Pumps. For further information on either Axelson Plungers or Liners write for additional literature and prices.

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OIL WELL PUMPS AXELSON SUCKER RODS

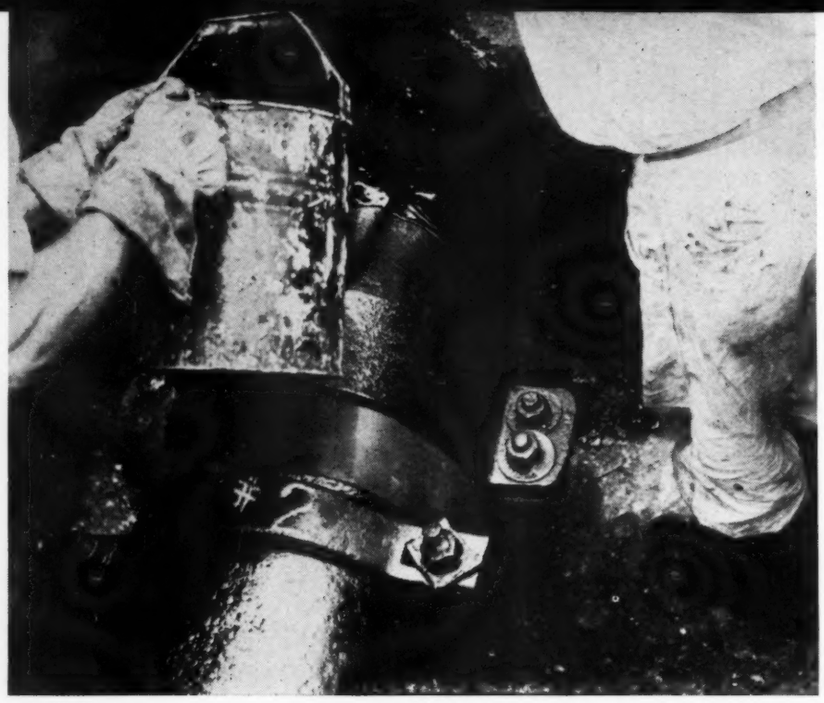

Fig. 3

reasonably priced because of the unavoidable waste and poor coverage to be expected on numerous short jobs such as these.

It has been standard practice with this company to coat all new lines of any size with pitch enamel, as well as all pipe that has been relaid in the last three years. A pitch enamel has the following drawbacks for use in reconditioning bell holes dug out for repairing leaks:

1. Critical application temperature of between 380 and 400 deg. fahr. cannot always be assured by the leak repair crew, although it can be maintained on big replacement jobs.

2. Pin holes in coating perceptible only by use of efficient holiday detector would necessitate a complete outfit and man to operate it with each leak crew.

3. The only pitch enamel coatings considered had long drying times on the primer used, averaging an hour or better. Leak crews cannot wait that long, especially if water is running in the bell hole.

4. In the reconditioning of coupled lines each leak repaired on a coupling would mean the use of two hot dope pots full of different materials, or the use of only coupling compound for leak repairs.

5. All pitch enamels examined were very expensive, and though the total footage per year is not high, the material cost will run high over several years' time, especially on a large system with thousands of leaks repaired per annum.

6. All pitch enamels examined emitted phenol fumes when heated to application temperatures. These fumes make for unsatisfactory working conditions in a hole five feet deep.

Hot asphalt or cold grease paint seemed to be the answer, but we knew by experience that most hot asphalt applications showed water absorption in about two years, and that grease paints had an extremely bad habit of coming off by flotation or saponification in alkali soils; also, a grease paint renders the pipe on which it is placed unfit for the application of other coatings without an expensive cleaning operation.

Fortunately, the problem was solved for us by accident. In an old recorded test hole on an asphalt coated section of the line some grease had been smeared over an incision made in the coating for examination purposes. We dug this out again two years ago for further examination and found that the asphalt had blistered away from the line due to water absorption in every place except where the grease had been smeared on it. We knew this was two years old as, fortunately, a record had been kept; so we "went into a huddle" in the laboratory to try out the "find." A 4-in. nipple was coated with hot asphalt and grease smeared over it, and then the whole wrapped in a fabric wrapper. Its initial resistance was 15 megohms per cu. cm., which was satisfactory, and after it had remained in salt solution in a bucket for six months it was still the same. Like many another paradoxical discovery the theory of operation was formulated from the results obtained. Simply, the grease closes the pores in the asphalt and penetrates it to about half its thickness, since it is a kindred substance. This stops water absorption, and since the grease does not penetrate to the pipe, the adhesion of the asphalt keeps the grease from leaving where it has penetrated the coating, even though the surplus grease may be removed by flotation. It was found also that the excess grease provided the paper wrapper used with a slip-joint freedom by means of which it was able to resist soil stress—something like mother greasing the dish to keep the hot fudge from sticking to it.

Once we had found a coating that apparently met all the requirements, we set about to devise a standard practice of application and train all leak repair crews to follow it. The first step was to equip all such crews with 25-gal., kerosene-fired, hot dope kettles

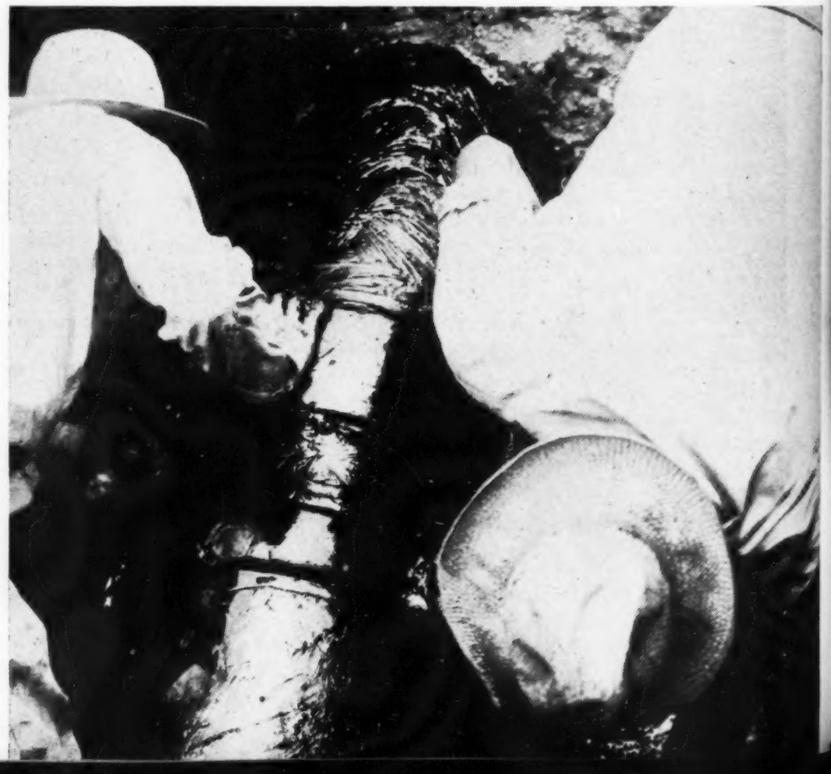

Fig. 4

Fig. 5

Fig. 6

supplied with asphalt thermometers. The asphalt selected has a 165-deg. fahr. melting point and has a non-critical application temperature of between 280 deg. and 380 deg. fahrenheit. It is possible for an experienced dope man to guess within these limits without reference to his thermometer. It was decided to wrap the line with 80-lb. Kraft paper, since this was very cheap and has the added advantage that an 18-in. width of it can be used to rag the underside of the pipe instead of the usual canvas sling. Best results were first obtained by using an asphalt and naphtha primer that was cut back with water-white gasoline until it dried in from ten to 30 minutes, depending on weather conditions. However, since we began this leak reconditioning, we were able to improve the operation by the use of an asphalt and creosote primer that requires no drying time, adhesion being obtained by absorption of the volatiles in the primer by the hot asphalt coat within a period of 18 to 24 hours. This has been a great help in speeding up the operation.

Fig. 2 shows a typical bell hole with the second leak clamp in place after it had been scraped and primed with an asphalt base primer. In between the scraping and the priming operations, however, the pipe is thoroughly brushed with heavy wire brushes.

Fig. 3 shows the pouring operation of the asphalt. The man at the right holds the Kraft paper under the line and rags the underside while his partner pours the hot asphalt on the top from a duck-billed pouring pot.

In Fig. 4 the pipe is well smeared with heavy grease. Either plain cup grease or any of the good grease paints containing rust-inhibiting chromates ground up in them are satisfactory. As heavy a coating as is shown in the photograph is not necessary or desirable, and a coverage of about one-tenth of a lb. per sq. ft. seems to work best.

Fig. 5 is the final operation of wrapping the affected area with 80-lb. Kraft paper cut in convenient lengths. The grease penetrates this paper, as well as the hot asphalt, and renders

Fig. 8

Fig. 7

it waterproof. The paper also serves to protect the coating from distortion due to backfill and soil stress.

Fig. 6 illustrates the manner of doping couplings. A double thickness of 36-in. Kraft paper is wrapped securely about the bottom of the coupling and drawn up tight against the pipe with a heavy piece of string placed about six inches on either side of the followers that holds it in position. Hot asphalt is now poured over the top of the coupling until the level of the liquid has risen to more than halfway up the side. The strings at the ends prevent the asphalt from running out and may be substituted for by long 1½-in. luggage straps if many couplings are to be poured. The paper is drawn up tight against the followers and when the hot asphalt fills it the bagging of the paper away from the outside of the bottom of the followers allows these to be doped also. When the paper is full of hot dope a flat catch pan is placed under the coupler and a hole punched in the paper. This allows all the surplus hot asphalt to run out into the pan and it is returned to the pot for future use. The paper is left exactly in this position and grease is smeared over the outside. The grease penetrates the asphalt after first going through the paper. This job is not a pretty sight, but seems to work very well and is quite fast, the operation requiring the greatest amount of time being the cleaning of the coupling before priming.

Fig. 7 illustrates the necessity for a quick-setting coating. Here is shown a bell hole full of water on the edge of a creek being bailed out preparatory to installing a second leak clamp between river weights on the line. The water ran into this bell hole at a terrific rate, and constant bailing was necessary to clean, prime, and coat the line satisfactorily.

Fig. 8 shows the same location at the end of the greasing operation and just before the pipe was wrapped in paper and the bell hole allowed to fill with water and slush. It is such locations as these, where repeated excavating has been necessary for the purpose of putting on the second clamp, that this coating job has proved most effective.

In conclusion, a brief resumé of results obtained is given: More than a mile of large-diameter pipe, 12¾ in. 16 in., and 18 in., has been reconditioned in the last year and a half. All this has been done in connection with leak repair in bell holes ranging from 5 to 12 ft. in length. We have been forced so far to return to only four leaks for the purpose of repairing holes under coating. Our records indicate that the time interval between installation of first and second leak clamp previously was 30 to 60 days. Special test jobs, having a record of two years in the ground, show excellent condition of coating upon reexamination. Sample coating jobs exposed to atmospheric conditions also show good weathering. The grease does not dry out, and the asphalt retains its elasticity due to its volatile components being completely sealed within.

Pipe Line Station Operation

By ELTON STERRETT

Each year sees the introduction of minor improvements and refinements to pipe line station operation, which, if taken singly, might appear as little progress, but when viewed in the aggregate represent considerable advancement in this branch of the petroleum industry.

A SUMMARY of pumping equipment installed the past year indicates that approximately 75 percent of the new units went into existing stations for increasing capacities, or to care for extensions to existing lines. Of the equipment installed in new stations, approximately one-half — on a horse-power basis — was transferred complete from older installations, and in consequence involves but little change in operating practice or pumping characteristics.

In established stations there is noticeable a gradual improvement in operation detail. Throughout the East Texas field, to use that area as an example, increasing indications that the field should continue to produce in great volume for many years has led to the mapping out of an extensive program of plant and mechanical betterment.

During East Texas' period of maximum flow, the Diesel or gas engine in station service, which was equipped with a cleaner for its intake air, was the exception. Now, urged in part no doubt by the dense clouds of abrasive material sifting in at times from the great "dust bowl" farther west, that engine not having some type of air cleaner is rare. Where dust conditions are most severe, the preference seems to be toward the oil bath or oil-moistened maze, as being easier to clean, as well as presenting on its outer surface a more ready check on the need for being washed or flushed out.

Another aid to bettered engine operation is the more general adoption of adequate filter and cooling, or, for

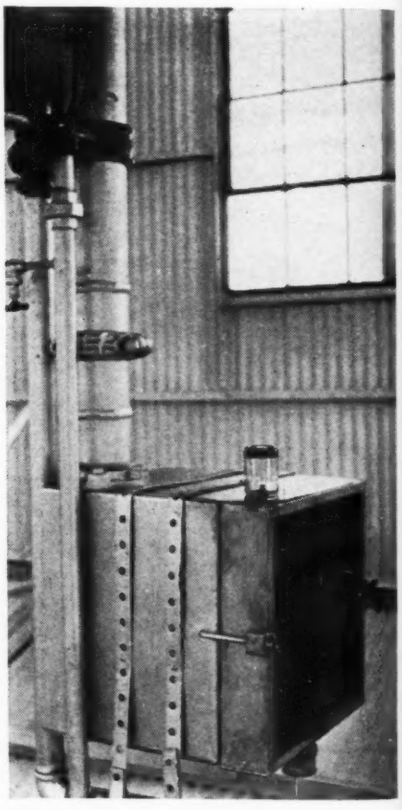

Fig. 1. Extruded metal maze with wick oil feed stops all dust on this gas engine intake

(Continued on Page 58)

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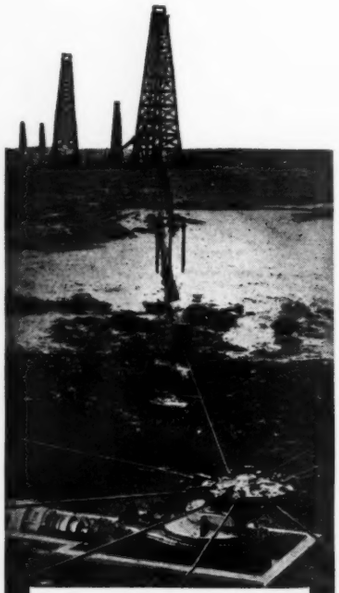
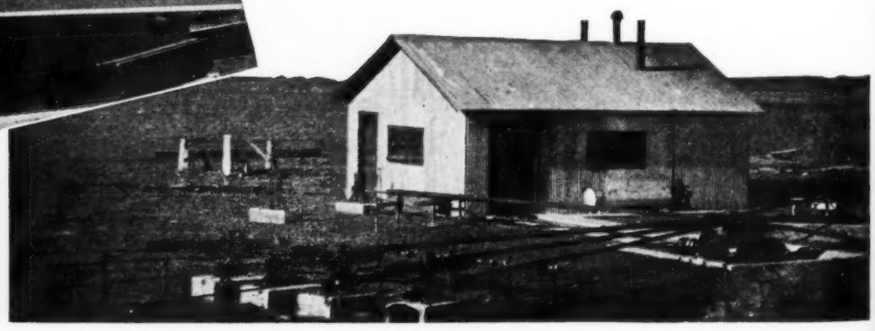


This 30 - S C "Oilwell" Geared Power is direct-driven by a gear motor, handling ten 1700 ft. wells near Fellows, Calif.

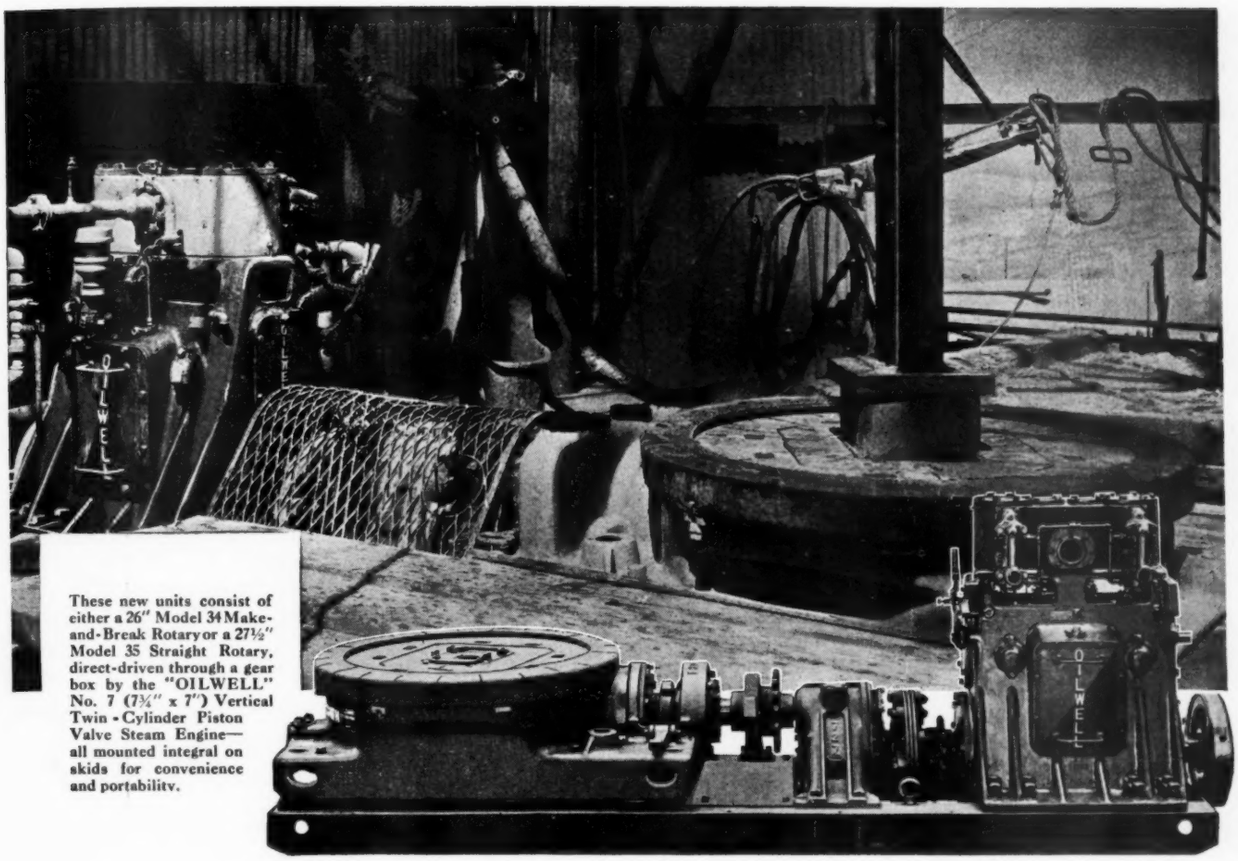
(*Above*) TC-35 "Oilwell" Pumping Unit in California, driven by multi-cylinder engine.

(*Below*) 80-SC "Oilwell" Geared Power on a major producing company's lease in Kansas.

(*Above*) This SC-20 "Oilwell" Pumping Unit has a wheel type crank and back crank arrangement for pumping 3 wells at Gladewater, Texas.



the "OILWELL" *way*



These new units consist of either a 26" Model 34 Make-and-Break Rotary or a 27½" Model 35 Straight Rotary, direct-driven through a gear box by the "OILWELL" No. 7 (7¼" x 7") Vertical Twin-Cylinder Piston Valve Steam Engine—all mounted integral on skids for convenience and portability.

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Branch Stores in All Oil Fields

"OILWELL"

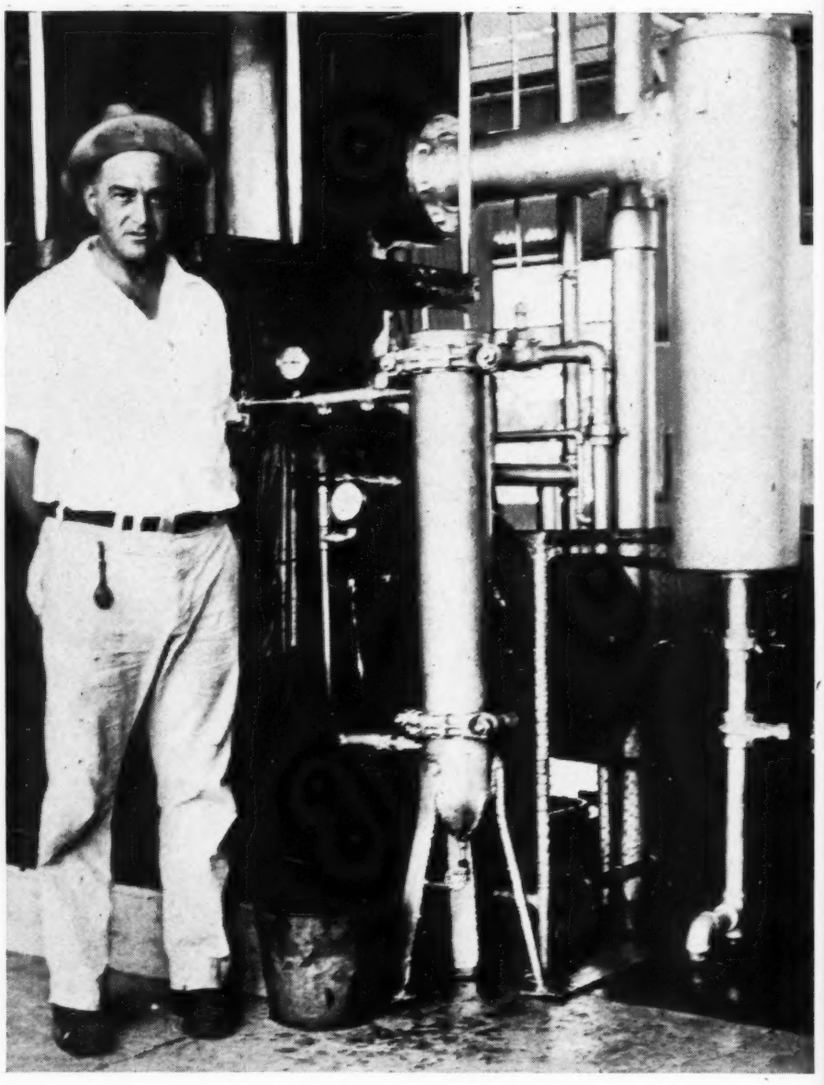

Fig. 2. Cartridge type of oil filter that gives 1000-hour service on 200-hp. gas engine

(Continued from Page 54)

winter operation, warming provision on the lubricating system. For the filtering of crankcase oils the engineer, if left to choose his equipment, generally selects a filter comparable to those found on most automobiles; it being easier and more effective to extract the old, sludge-charged fabric filter section and replace it with a new unit than it is to attempt to clean any form of metallic mechanical filter and get it again into shape where it will present anything like the effective area found therein when fresh from the factory.

Temperature control of crankcase or engine sump oil, originally aimed solely at preventing the lubricant from becoming too heat-thinned for efficient use, now is being revised to provide for the maintenance of a more nearly uniform oil temperature, regardless of calendar or engine conditions. Where the outside type of oil cooler is used, with cold water circulating around coils carrying the oil, or through other conventional types of heat exchangers, station lines are now being changed over so that during cold weather hot water may be pumped through the system and thus oil of the proper consistency be assured the engine bearings at the time of starting up—when they are most frequently starved for lubricant due to sluggish flow failing to replace immediately the oil drained away during the stand-by period.

Electric heaters, their resistance elements and current leads fully protected against oil seepage, are being used experimentally as a means of heating the oil within engine bases preparatory to starting up during cold weather. Where such an installation is thermostatically controlled, so as to open the circuit when the oil reaches a predetermined temperature either through action of the heater itself or through warming up of the engine under service, the cost of current consumed is small, and the danger of "burning" or "scorching" the oil removed. If such a heater be used, experiments—though as yet incomplete—seem to indicate that a natural circulation of hot oil away from and colder oil toward the heater element safely can be counted upon if the depth of oil in crankcase or engine sump is three inches or over; but that if the oil bath is thinner than that, adequate oil warming and the necessary cooling of the electric heater best can be obtained in engines of four or more cylinders by placing individual heat units in each end of the base.

Where the surrounding territory is gridded by adequate public service transmission lines from two or more independent sources of current, the motor-driven pump is widely used; though here the choice of prime mover often depends largely on that already selected as standard by the pipe line company. In stations on new lines, and those being built in new fields to feed through more or less abbreviated lines—as pipe lines usually go—into existing mains, the electric drive is coming into more general use in the smaller fields of the Texas and Louisiana Gulf coasts and in southwestern Texas.

When motor drives are specified, the centrifugal pump follows in most cases, it permitting direct drive from the motor with no accessory transmission other than the flexible coupling. Where high-speed Diesels are being installed the centrifugal pump likewise is adopted, but when moderate or slow-speed engines are used and the driver-to-driven reduction is not over eight to one, the earlier trend toward plunger pumps still is in evidence.

As a result of the selection of proper packing, plunger pumps do not need the frequent gland attention formerly required. Even on pumps with plungers having a record of 30,000 to 50,000 operating hours it is no longer unusual to find packing that has been in service ten, 12, or even 18 months against pressures ranging as high as 900 lb. per sq. inch. Selection and correct installation of proper packing also has cut to one-third its former figure the percentages of gland stud failures.

Distant-reading gauging devices, for indicating stocks in station tank farm tanks, are gradually being introduced, though like the gyro-compass steering device for ships, there seems to be a strong tendency to continue to check the operation of the mechanical indicator by an old-fashioned gauge line in the hands of a trained gauger.

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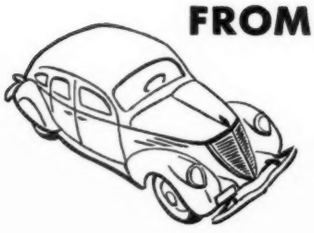

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Where installed, it has seemed difficult to evaluate accurately the minute shift of the indicating end of the recording mercury column—the reading of the top of the column even by trained men varying considerably more than the spread of steel gauge line readings when taken by the same gaugers. If a check is desired at intermediate stations floating on a line, the reading of this type of mechanical gauge indicator for determining the oil in the "over and under" tank is sufficiently accurate even with the spread introduced by the personal factor; but for delivery of oil to a foreign line or its acceptance by pipe lines from outside producers, reliance continues to be placed on steel tape readings and the standard tank strappings.

Station lines, manifolds, and what might be termed yard accessories also have been improved during the past year. In a number of instances the entire manifold system has been worked over as occasion offered and the earlier, rigid, all-welded set-up revised by the installation of various kinds of flexible and expansion joints, of which the types using a self- or pressure-packed rubber ring are widely employed. The resultant breaking up of rhythmic or sonic vibrations in suction and discharge lines through such change has been found to decrease materially the probability of leak through line crystallization or the failure of bolts or studs in flange connections from the same cause.

As a result of tests culminating during the spring of this year there has been a widespread trend toward rigid scheduling of scraper runs through all crude carrying main lines, some companies ordering the scraper on a basis of operating days between runs, others arriving at much the same result through starting the "go-devil" after a predetermined amount of oil had been run, while the third plan regulates the frequency of the line cleaner use by the increment of pressure shown at the discharge end of the pumps. Here, again, the fact that pumps and lines are not being loaded to capacity removes a part of the emphasis that would be placed on careful clearing of paraffin from pipe lines were maximum throughput being demanded.

A number of interesting experiments with the standard form of "go-devil" are being carried out this summer by at least two of the major companies in the East Texas field, following up their work earlier in a continued attempt at reducing or prohibiting paraffin accretions in their mains.

One extensive series of runs, just completed, involved the use of various chemicals at intervals just previous to, with, and following immediately after, the run of a scraper. Although complete findings thereon are not available, it appears that with the possible exception of a slight additional clearing effect on the paraffin left by the scraper when fed through the line closely behind the mechanical cleaner, the chemicals are either too diluted, or hurried excessively by the velocity of flow in the line, to give results commensurate with the additional expense involved.

In this connection a close check of pressures on one line, both at the pump station itself and at gauges installed along the line, was made after chemical agents had aided materially in clearing paraffin deposits in field tanks and gravity lines. As far as could be noted from pressures recorded, and comparison with other records while pumping crude received from the field untreated, the chemical had no appreciable effect on line conditions.

Due to the limitations of most fields by proration enforcement, and where outside oil has not been added, obsolescence of station equipment has resulted in the retirement of but few units; capacity installed during periods of greater or less closely regulated production being ample for most needs. Where such station machinery has been scrapped, however, the tendency is to replace it with the latest and most improved type available, and thus to endeavor to establish a basis for future operating economy against that time when greater and more persistent pressure will be brought to bear to reduce pumping costs.

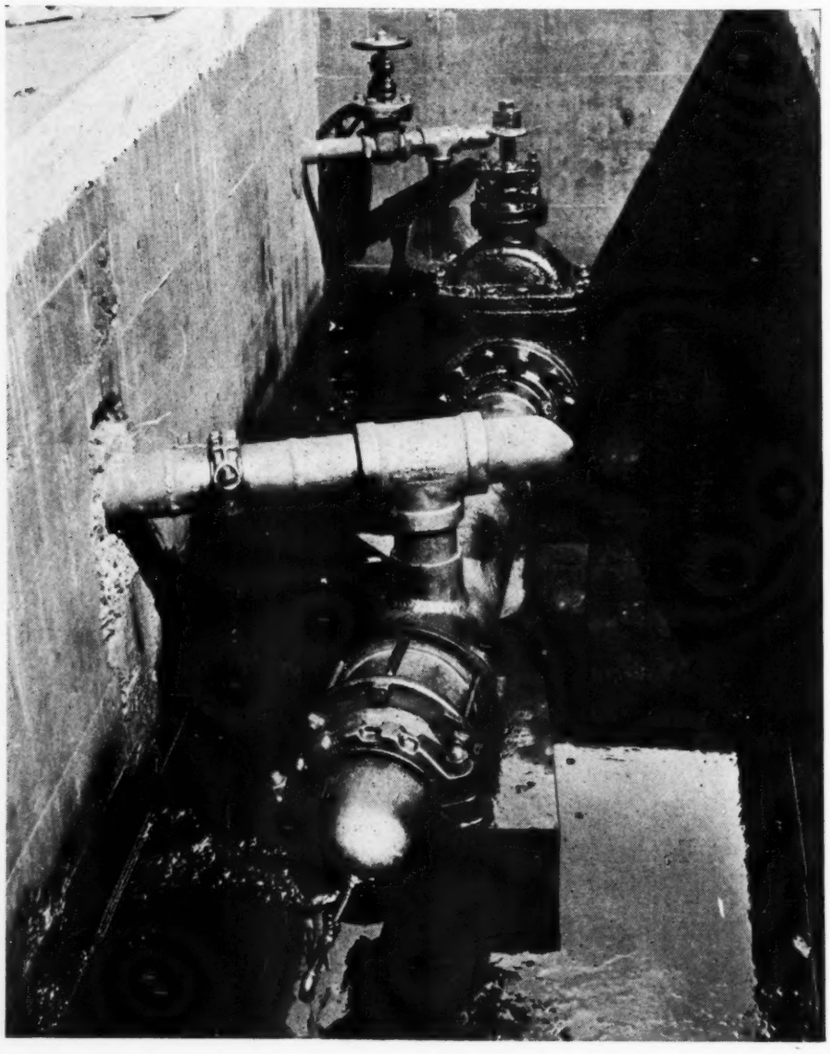

Fig. 3. Rubber-packed joints on this scraper "gun" afford flexibility and accessibility

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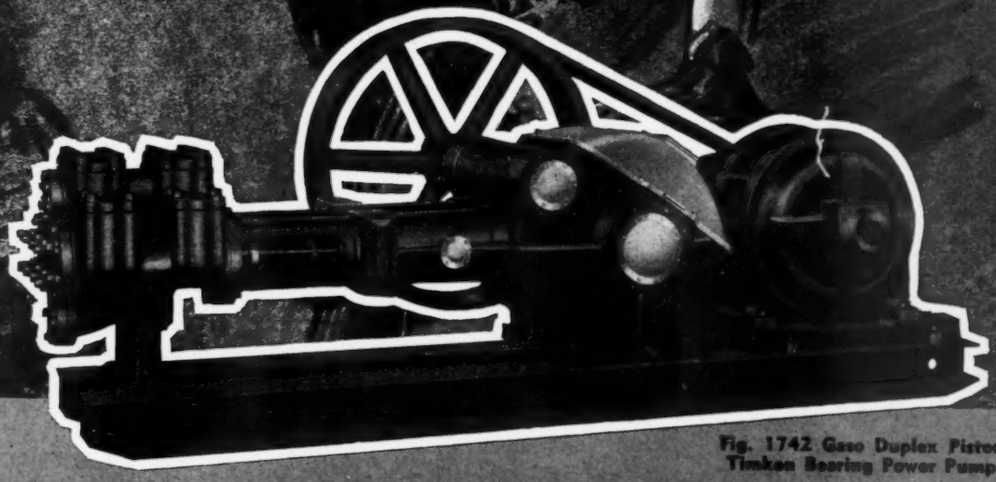

Fig. 1742 Gaso Duplex Piston
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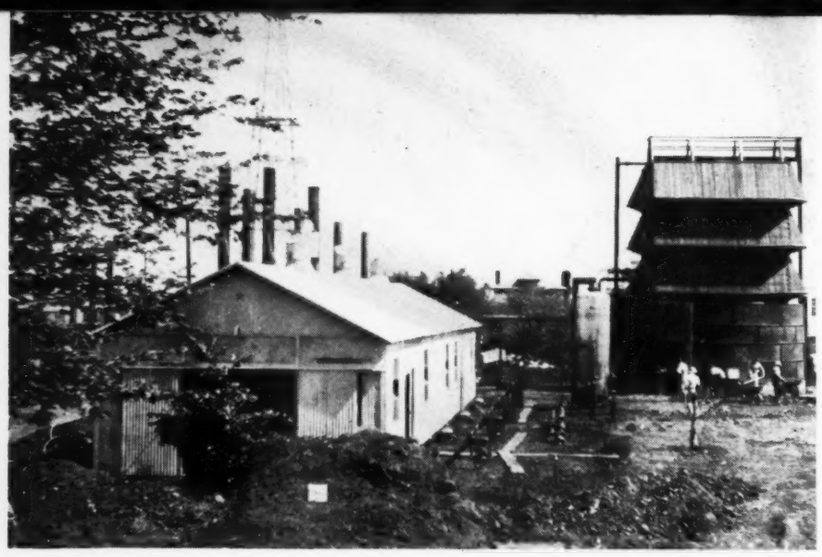

Francis gas-lift plant of Hall & Briscoe, Mansion Area, Oklahoma City

Progress in Gas-Lift Practice 1935-1936

By S. F. SHAW*

FEW departures from regular practice in gas-lift operations have been developed during the past year. There has been improvement made in the older methods, also there has been gained a better grasp of the factors and conditions involved in gas-lift operations. Perhaps the principal development during the year has been the use of the gas-lift-Reda pump combination method for handling large production in deep wells where the reservoir pressure is low. Further mention of the work will be made later in this article.

Gas-Lift Operations in California

In California, published reports of operations during the year indicate that gas-lift has been employed for completing wells at Elwood, Inglewood, Kettleman Hills, Long Beach, Playa del Rey, Santa Fe Springs, Seal Beach, and West Coyote.

Approximately 260 wells in California are produced on gas-lift.[9] These include the Brea-Olinda field with 24 wells; the Dominguez field with 23 wells; the Elwood field with 11 wells; Huntington Beach; Inglewood; Kettleman Hills; Long Beach field with 27 wells; Playa del Rey; Richfield field with eight wells; Rosecrans-Athens; Santa Fe Springs field with 48 wells; Seal Beach; Ventura Avenue field with 25 wells; and West Coyote.

Numerous wells in the Kettleman Hills field have been equipped with gas-lift, and operators seem to be turning gradually to that method for handling the lifting problem in these extremely deep wells.

A few installations of the plunger lift have been made in Long Beach and elsewhere in California.

Progress in Gas-Lift Work in Texas

In Texas the number of wells being placed on gas-lift has increased gradually during the year, the chief increase being in East Texas where it has been found that the investment for equipment, when using the gas-lift or air-lift method for handling severely restricted production, is surprising low. In most instances the compressed gas is supplied from gasoline plants employing the compression method for extracting gasoline, the residue gas being pumped into the gas mains at a pressure of 250 to 300 lb. Individual plants of single units, with about 75 to 125 hp. capacity, driven by direct-connected gas engines, are being installed on several leases for handling lifting operation of a group of wells.[10]

In other parts of Texas, notably in Bee and Duval counties, starting collars are employed for handling wells that will not start on natural flow after having been closed-in for a time. Compressors are not used on these shallow wells, as a rule, since gas from gas wells usually is available for the purpose. In instances where the wells will not flow naturally after having been started, gas is admitted continuously until the day's allowable has been produced.

"Jetting," or the use of starting collars, is employed in various Gulf Coast fields for starting wells through tubing, either by means of gas confined in the annular space in the well itself, or by gas from another gas well. There would seem to be a greater field for this method, after a better understanding has become more prevalent and better equipment developed for this work. The expense at present of equipping a deep well with starting collars is a severe handicap if the well has a small allowable.

Several domes along the Gulf Coast that were explored for oil developed into large sulphur deposits. Most of the sulphur is extracted by the Frasch process in which the air-lift is employed for removing the molten sulphur from underground deposits.[5]

No. 5 Cary, Westgate Oil Co., Oklahoma City, on gas-lift-Reda pump combination method

Gas-Lift in Oklahoma

Probably the greatest use of gas-lift for handling production is in Oklahoma, and most installations are in the Oklahoma City field.

Practically all gas-lift operations in the greater Seminole area have been closed down, due to abandonment of wells, to flooding of wells by water, or to wells being placed on the beam. At one time, production on gas-lift in this field was between 200,000 and 300,000 bbl. per day.

Reduced pressures in the Lucien and Crescent fields, insufficient volume of formation gas, and the considerable encroachment of water, are bringing about increased interest in artificial

*Consulting Engineer, San Antonio, Texas.

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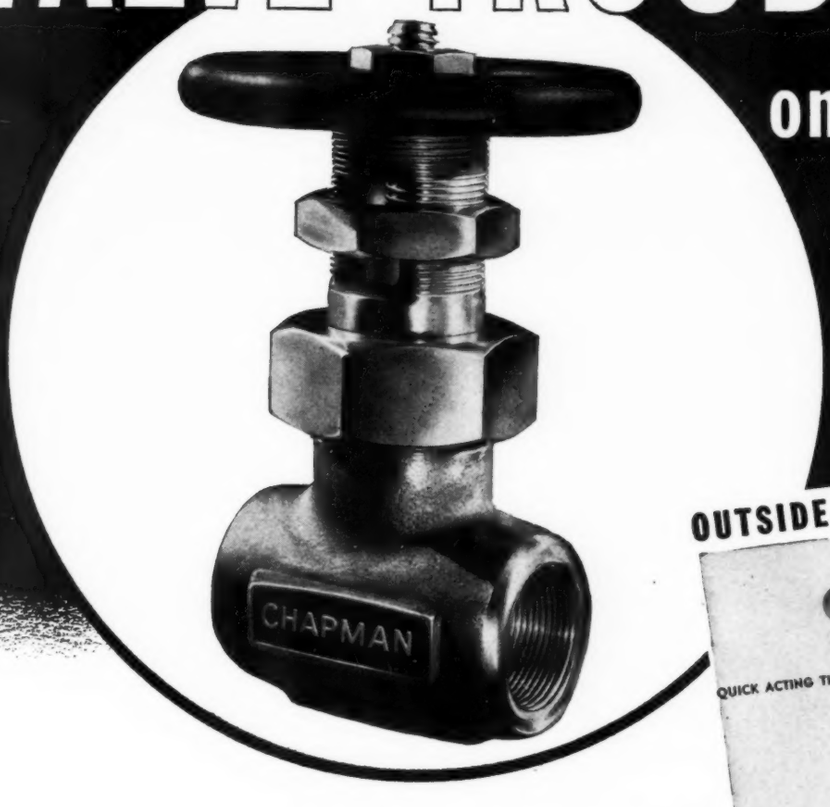
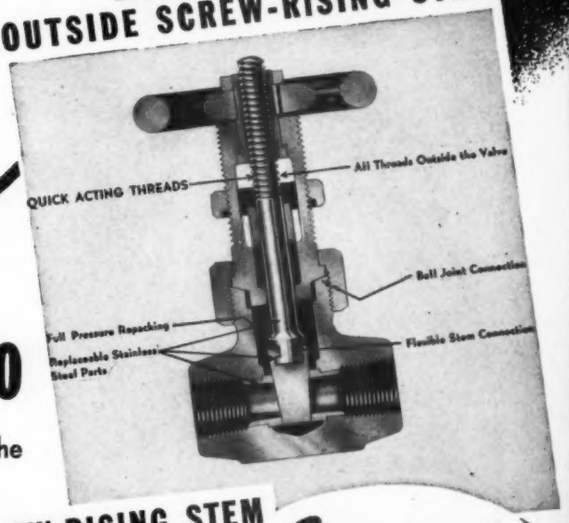


OUTSIDE SCREW-RISING STEM



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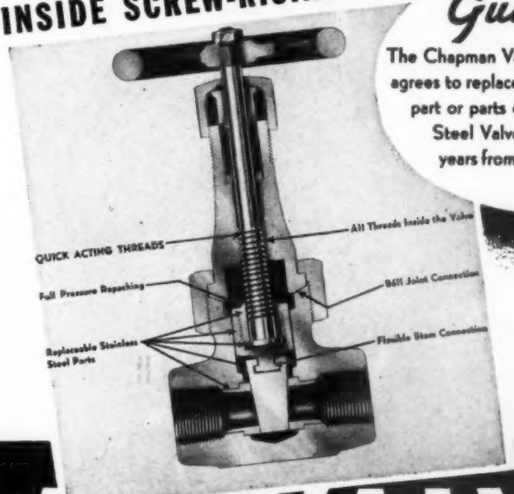

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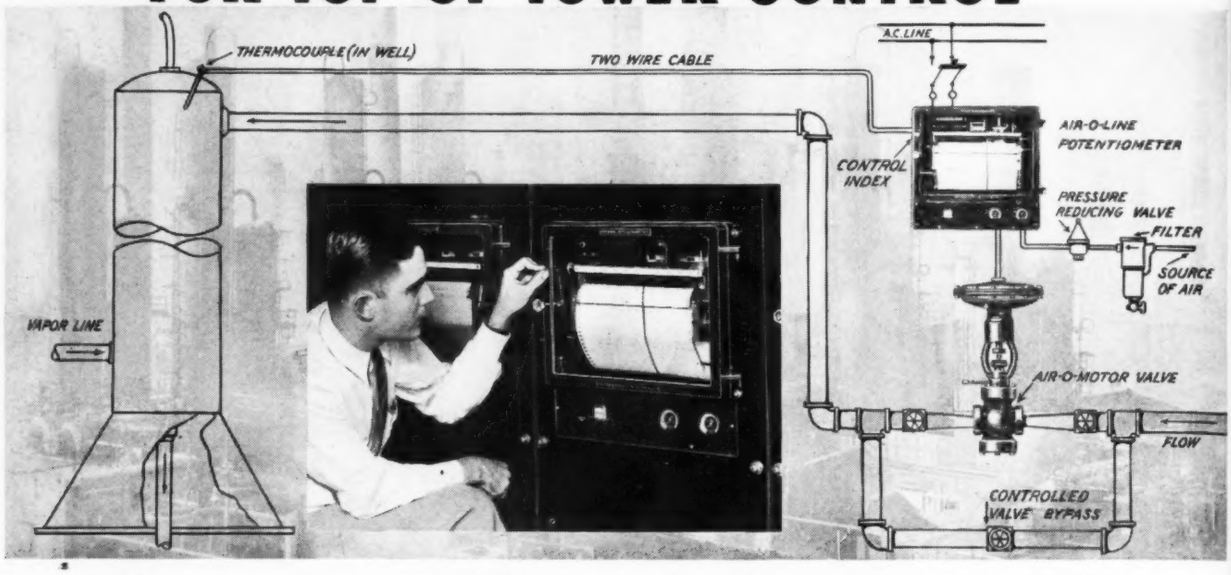

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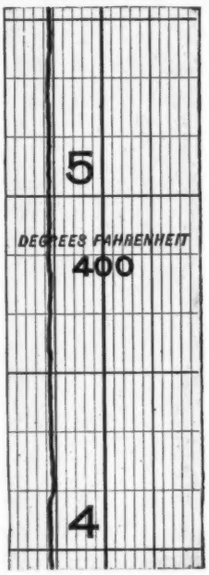

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Gas-lift plant of Barnsdall Oil Company in the Mansion Area, Oklahoma City, with four 230-hp. compressors

lifting methods in those two fields. A few small compressor plants have been installed, and some wells are now on gas-lift. Some of the wells will flow naturally after being started by gas-lift, others require continuous use of gas-lift. The plunger-lift is gaining ground in both fields, which may prove to be of a type where lifting can be successfully handled by this method after some of the difflculties have been overcome. There are four plunger-lift installations with 2½-in. tubing installed at Lucien, and one plunger-lift with 3-in. tubing in the Crescent field.

Though reservoir pressures in the Lucien and Crescent fields are still fairly high, flowing pressures are considerably lower, due to the relatively lower permeability of the sand, particularly in the Lucien field. Under these conditions, the problem is not so much that of lifting large quantities of fluid at certain times as it is that of handling the normal flow into the well by utilizing the reservoir pressure to maximum advantage.

Pressures in the Edmond field are yet high; however, two plunger-lifts, one with 2½-in. tubing, the other with 4-in. tubing, have been installed in this field.

Pressures have been weakening to a considerable extent in the Fitts field and water encroachment is making itself felt. During the coming year there probably will be the necessity for considering artificial lifting in many of the wells in this field. The depth is about 4200 ft., and so far as actual lifting by gas-lift is concerned the problem is simple, but since several sands have been penetrated in the same well and allowed to intercommunicate, it is expected that underground problems will be most complicated. It seems possible that if withdrawals are severely restricted during the coming year, many of the wells will be placed on the beam, due to there being less mental inertia to overcome in installing this method; but if large withdrawals are permitted, it is probable that gas-lift will be employed to a large extent.

One well in the Binger field, at depth of approximately 10,000 ft., has been produced from time to time on gas-lift, but the production so far is of little consequence, and no data of an informative nature have been obtained.

The Oklahoma City field, with wells 6500 ft. in depth, has the widest application on gas-lift, and the most marked in improvement in understanding and technique, of any field at the present time. However, many of the wells that were formerly produced on gas-lift, in which casings of 6⅝-in. and 7-in. O.D. are employed, have had a decline in reservoir pressure to the extent that the cost has become prohibitive, especially where gas for flowing the wells is purchased at 8 cents per thousand cu. feet. Many of these wells have been placed on the beam.

Due to low reservoir pressures, many wells with 6⅝-in. casing and 7-in. O. D. casing were placed on intermittent flow during the preceding year,[11] but many of these wells since have been placed on the beam. The type of intermittent flow that has been successful over a long period in this type of well is the plunger-lift. Some wells with small casings have been pumped by this method until they were virtually ready to be abandoned.[13] There are now 25 wells with 2½-in. plunger lifts, four with 3-in. tubing, and two with 4-in. plunger-lift in the Oklahoma City field.

Wells completed in the Oklahoma City field that have 9-in. and 9⅝-in. casing have remained on continuous gas-lift for the most part, or on the gas-lift-Reda pump combination method, even in instances where pressures have declined to a low point, that is, 100 to 150 lb. Tests of wells have been made under normal conditions with large size casing, and in one instance it was found that with bottom-hole flowing pressure of 60-lb. the production on straight gas-lift totaled 550 bbl. per day with an input gas-oil ratio of 5500 cu. ft. per barrel. This gas is compressed at an operating expense of 0.8 cents per thousand cu. ft.,[14, 16] a gas-lifting charge of 4.4 cents per barrel. It would seem that these wells would be able to produce about 100 bbl. of oil per day with a bottom-hole flowing pressure of 20 lb. With bottom-hole flowing pressure of approximately 120 lb., the production is about 2000 bbl. per day, and the consumption of input gas is approximately 2500 cu. ft. per bbl,[17] thus incurring a charge of about two cents per bbl. for gas for lifting purposes. It should be stated, however, that the figure of 0.8 cents per thousand cu. ft. applies only to the operating cost and does not include depreciation, and can be obtained only in plants having a capacity of 20 to 25 million cu. ft. per day.

Tubing sizes in wells of 8⅝-in., 9-in. and 9⅝-in. O.D. casing usually are 2½ or 3 in., 2½ in. predominating. At least one instance is known of 2-in. tubing being employed in a well with 9⅝-in. casing, but input gas pressures are extremely high.

The most important development during the past year has been the adaptation of the Reda submerged centrifugal pump for providing an artificial submergence for gas-lift wells.[4, 7] In wells in the Oklahoma City field making approximately 2000 bbl. per day through a 9⅝-in. casing, with bottom-hole flowing pressure of 120 lb., Reda pumps have been installed, being lowered to within 10 ft. to 100 ft. off bottom. A packer is set at 300 ft. to 1000 ft. above the pump, and the oil is lifted by the Reda pump above the packer and into the annular space between the tubing and casing. Gas is passed down the tubing and enters the annular space just above the packer, and mixes with the oil, lifting it to the surface on gas-lift. In effect, this is a gas-lift with column a few hundred feet shorter than the straight gas-lift in these wells, in which an artificial submergence is provided by the Reda pump, which increases considerably the capacity and the efficiency of the gas-lift. Under these conditions, wells that produced 2000 bbl. per day now are producing 5000 bbl. per day with input gas of approximately 1000 to 1500 cu. ft. per bbl., and electric power consumption of ½ to ¾ kw-hr. per bbl. lifted.

In one instance the cost of electric power averaged three cents per kw-hr., including demand charge, or about one and three-fourth cents per bbl. of oil, and the charge for compressed gas at 0.8 cents per thousand cu. ft. for 1250 cu. ft. was one cent per bbl., or a total lifting charge for gas and electric power of 2¾ cents per barrel.[16]

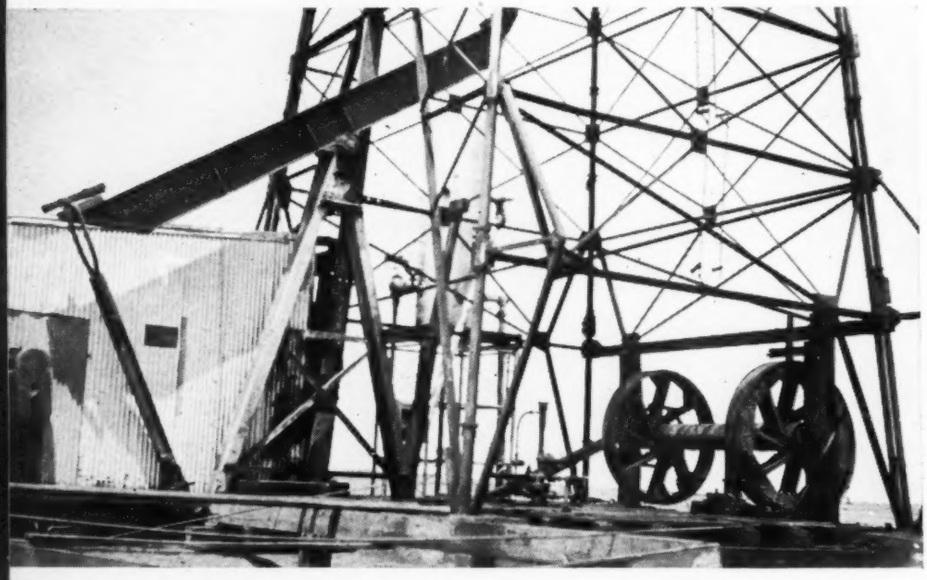
The treatment of paraffin by use of solvents in gas-lift wells has, in some instances, become a routine operation, and keeps the casing clean as long as the proper quantity of solvent is applied at the proper intervals. When interruptions occur in the treatments, paraffin settles out very rapidly, adhering to the casing walls, and a well can decline easily from 2000 bbl. to 500 bbl. in 30 to 60 days.[14]

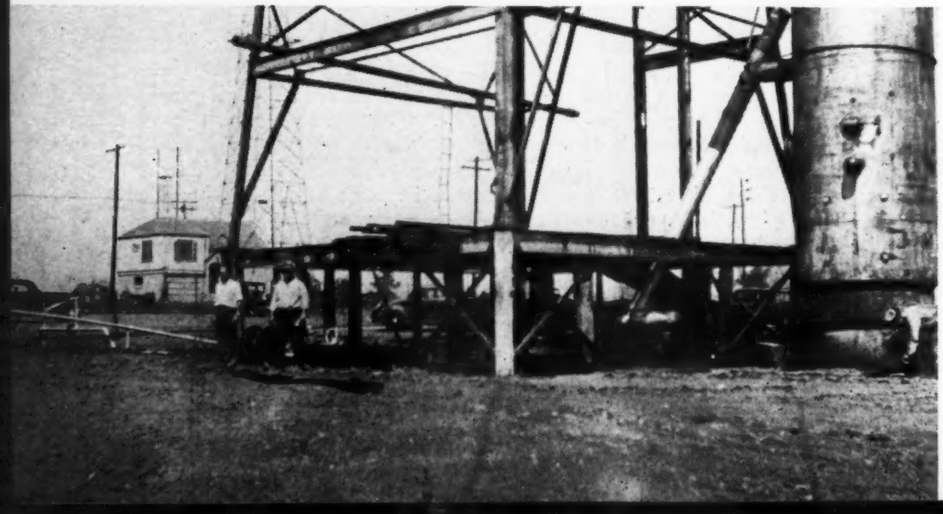
The latest development in gas-lift in the Oklahoma City field is that of the Mansion area, which surrounds the State Capitol and extends north about one mile beyond 23rd street. Almost 125 wells have been completed in this area, using casings of 8⅝ in., 9 in., and 9⅝ in. O.D. Most wells are completed with 8⅝-in. casing.[16]

Almost all the Mansion area wells came in during a period when the reservoir pressure ranged from 575 lb. down to 350 lb., thus it was important to prevent a 6500-ft. column of mud from being imposed on the producing sand, otherwise the mud would enter the sand, circulation would be lost, and the pores become clogged so that little oil and gas could enter the well. In order to handle this situation, the wells were brought in by circulating oil and compressed gas instead of mud while drilling in, and the bottom-hole pressure was reduced so that the oil would flow into the well.[3] The water and mud that remained in the hole after the casing was set was first blown out with gas-lift, then the regular drilling-in operations started.

The first wells completed in the Mansion area flowed naturally with initial productions of 10,000 to 27,000 bbl. per day. The wells completed about six months later for the most part were in areas that required gas-lift to produce them, and potentials in such wells ranged from 5000 to 12,000 bbl. per day. The wells along the west and north edges of the section were of this type.

Gas-lift plants have been built in the Mansion area as follows: Barnsdall Oil Company, Edwards lease, four 230-hp. Cooper-Bessemer units; Barnsdall-Fairfax companies, Bracht lease, eight 170-hp. Cooper units; Black Gold Oil Company, Sawyer lease, four Miller, 200-hp., units; Hall & Briscoe and F. C. Hall, Francis lease, four 260-hp. Ingersoll-Rand units; Superior Oil Company of California, Sibley lease, two 260-hp. Ingersoll-Rand units.





Top—No. 1 Wolff of Shell Petroleum Corporation, Lucien field, Oklahoma, on plunger lift

Below—Well in Mansion Area, Oklahoma City, with potential of 18,500 bbl. per day on natural flow

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Progress in Oxy-Acetylene Welding of Pipe Lines

By
S. C. CLARK*

New Construction Method Proves Successful on Short Lines

CAREFULLY planned "gang" organization for the best overall economy has been the rule in oxy-acetylene pipe line construction during the past year. This is especially noticeable in the case of short lines where the so-called "all bell-hole" or "stab-on" method has been used with marked success. Under this plan of construction the usual line-up and firing line gangs are eliminated and all welding and laying work is accomplished by a single, compact crew.

There are several variations of this method but each requires that every joint be bell-hole or position welded. The most common plan is to line up the pipe high on skids over the ditch, dug well in advance, then tack-weld the joints and weld each joint individually as a bell-hole weld. In addition to the tacker, from three to six operators are assigned to do this bell-hole welding, the number depending upon the speed with which the pipe can be lined up. Bends are made in various ways, depending upon the equipment available. When it is necessary to make a bend near a tack-welded joint the weld can be completed speedily by one operator or by two working together so that the bending can be done with little delay.

Another procedure sometimes followed is one in which two operators weld on the same joint simultaneously while a tractor with boom holds the free end of the pipe up off the ground about three or four feet. After the weld is completed the free end of the line is raised enough to permit taking out skids supporting the second joint and moving them ahead to keep the first joint off the ground. Another length of pipe is then swung into position and welded to the previously held joint of pipe, completing the cycle of operations.

The all bell-hole method is made

Above—Multiflame oxy-acetylene welding on a 20-in. gas line in Oklahoma. Full strength welds are made on plain beveled end pipe without any need for a liner

Below—On this gas line two operators welded at one time on a single joint, completing it, after which another length of pipe was picked up, tack-welded and welded to the end of the line and the cycle repeated

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Making a weld on a recently constructed 6-in. all bell-hole welded line

method has definite advantages because difficulties encountered in turning the pipe are eliminated.

On a job in Texas consisting of two short loops of 8-in. pipe, amounting to 13 miles in all, six operators averaged about 30 welds each for an eight-hour day. Reclaimed pipe of fairly heavy wall thickness was used and ends were flame beveled. On 21 miles of 6-in. gas line in Mississippi, six operators each completed an average of 45 overhead welds an eight-hour day.

Despite the greatly increased activity in pipe line construction, with a corresponding increase in the amount of oxy-acetylene welding being done, there has been an ample number of operators available who are capable of producing high-quality welds.

practicable by the rapidity with which bell-hole welds can be made.

The same welding rod, the same type flame and essentially the same welding technique as for roll-welding are employed in bell-hole welding. A somewhat smaller puddle is carried and since the operator changes his position occasionally in welding the joint it naturally takes a little longer to make the weld. As a general rule it takes but 10 to 25 percent longer to make a bell-hole weld and this is more than compensated for by the fewer laborers and equipment required, and by the compactness of the gang that makes control by a single foreman much easier.

Firing line multiflame oxy-acetylene welding is still standard for the longer lines where a high rate of daily production is desired and where the pipe is in good condition for roll welding. It goes without saying that where reconditioned pipe is used and occasional lengths are crooked, the all-bell-hole

Every joint was bell-hole welded on this 8-in. oil line constructed in Texas recently with reclaimed pipe

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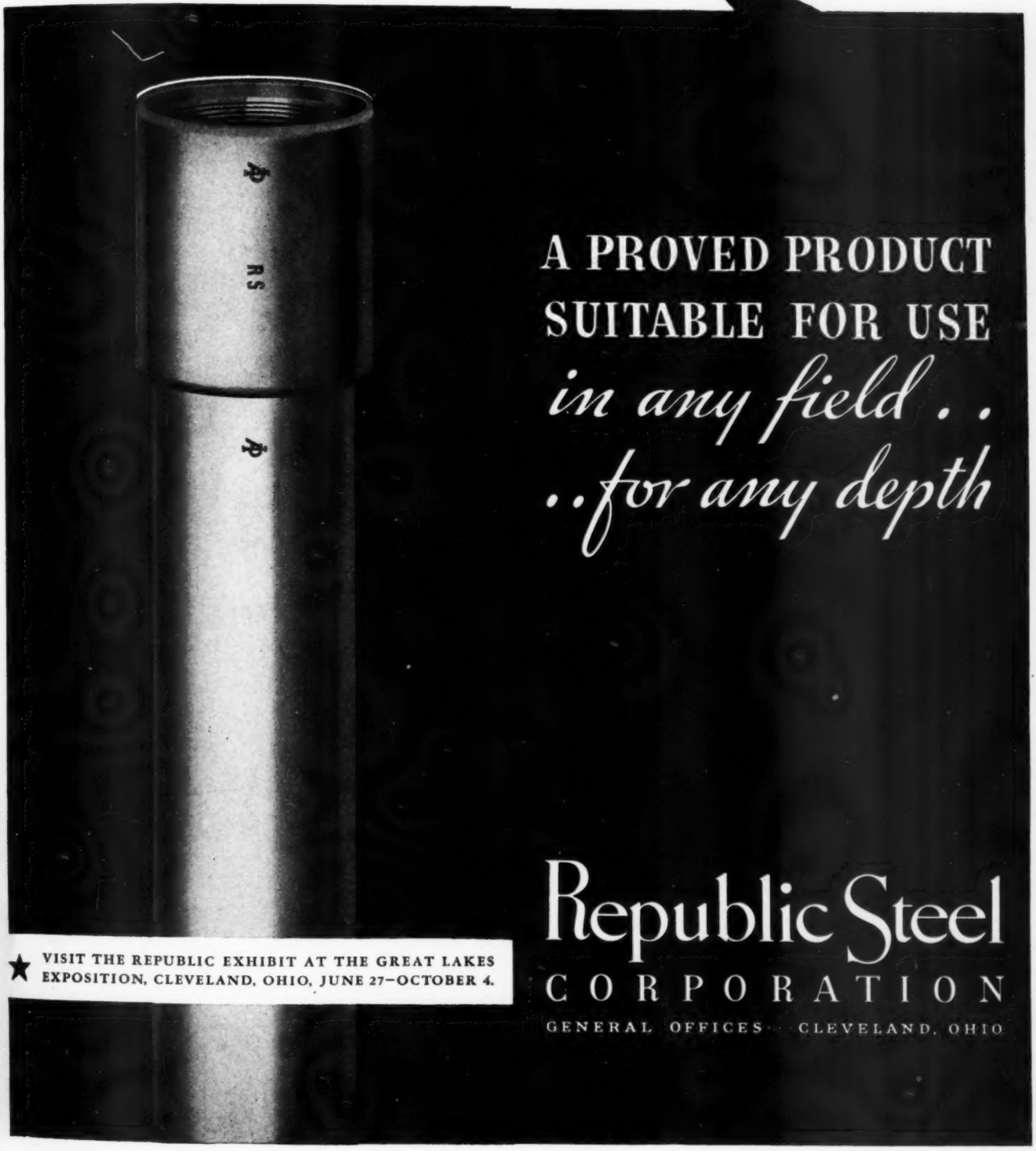

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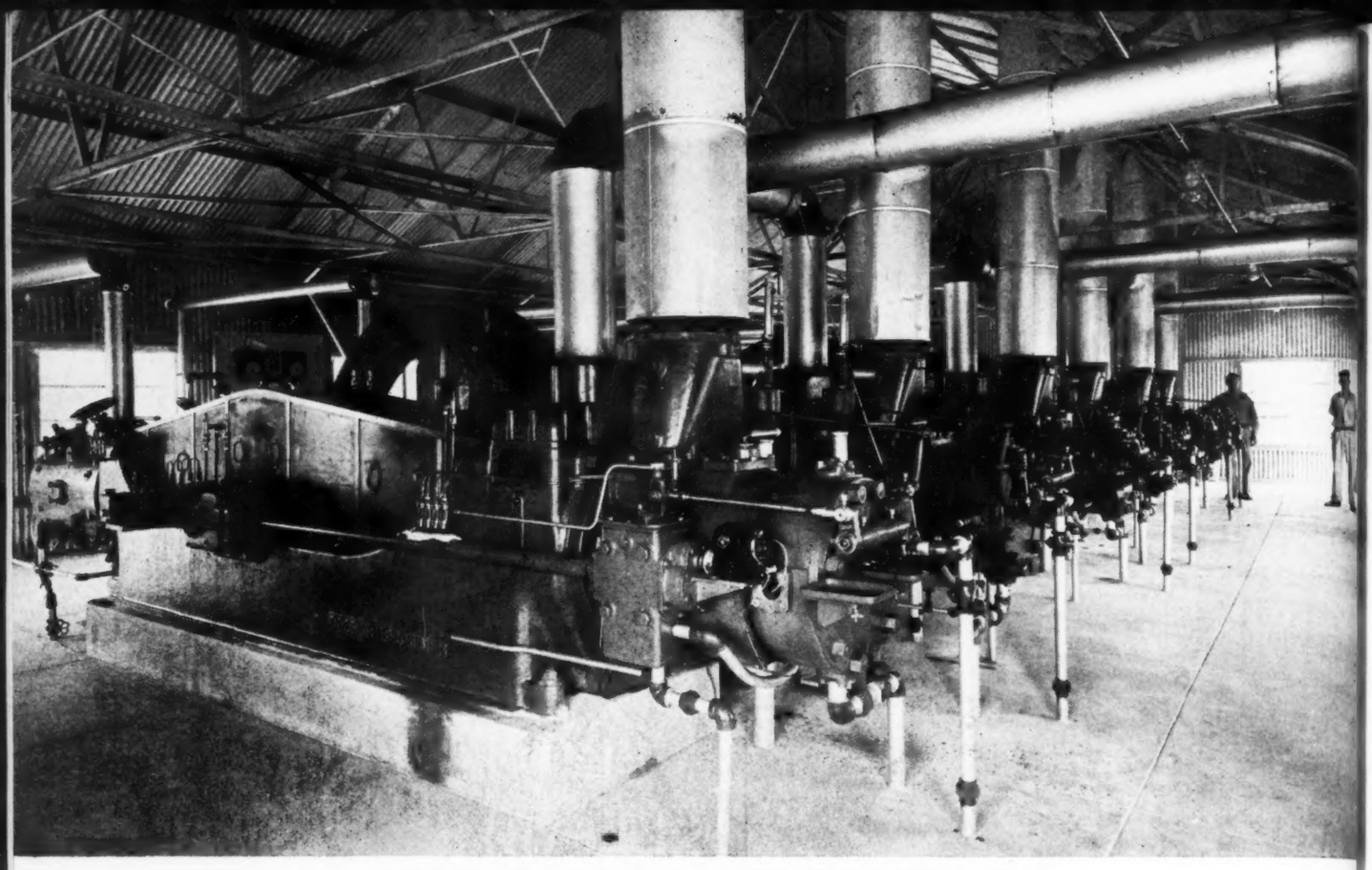

Interior view of a recently constructed compressor station in Texas

Progress in Gas Transmission and Compressor Station Operation . . . 1935-1936

Trend has been to more efficient and economical operation of transmission systems, and to the improvement in accepted prime movers employed in compressor stations

By

ROY W. PARKER, Oklahoma Natural Gas Company

THE rapid increase in the consumption of natural gas that began in 1935 has continued in 1936. During a representative period of this time the industry was serving 6,029,000 customers a total of 1,049,600,000 cu. ft. of gas, representing a gross revenue of $353,355,000. The total population of the cities now served with gas is approximately 80,000,000. These figures indicate a yearly gain of 3.1 percent in customers, a 9.3 percent gain in the volume of gas sales, and a 7.8 percent gain in total revenue. Such rather rapid increase is attributed to longer distances of gas transmission, from pools of known supply through high-pressure lines to unlimited markets.

Several of the larger projects as reported in *The Petroleum Engineer* the past year have changed the boundaries of natural gas service and introduced new methods of construction and operating practices. The principal gas line project of recent years was the Michigan Gas Transmission Corporation's 230-mile 22-in. line to Detroit, which effects a continuous carrier bringing natural gas 1,580 miles from the Texas Panhandle to Detroit, Michigan. While this was the largest project of the year, there have been hundreds of miles of transmission line laid during this period. The necessity for such an expansion program was realized by many companies during the past winter when transportation systems were found to be inadequate to supply the demand. The operation of the new gas conservation law in Texas also called for additional transmission facilities. Pipe line construction the past year or two has brought the total mileage of transmission lines owned by the major gas companies to 70,000. An analysis of these gas carriers shows about one-half of this total mileage to be of 8-in. diameter pipe or larger.

Transmission

The present trend in construction practices is toward more thought and consideration being given to how the completed system will lend itself to efficient operation. Transmission does not begin until construction has finished, and the successful operation of a system is dependent upon practical methods of economy and efficiency be-

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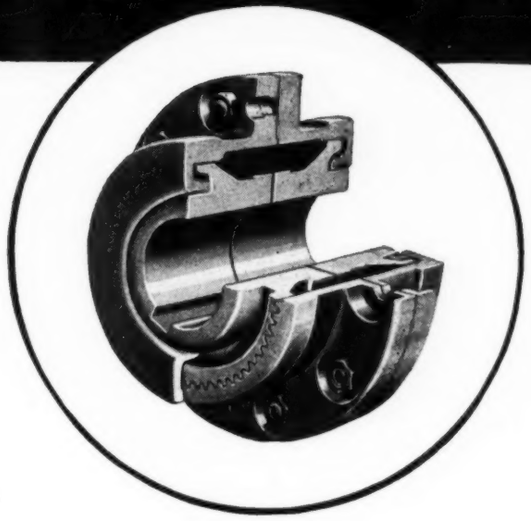

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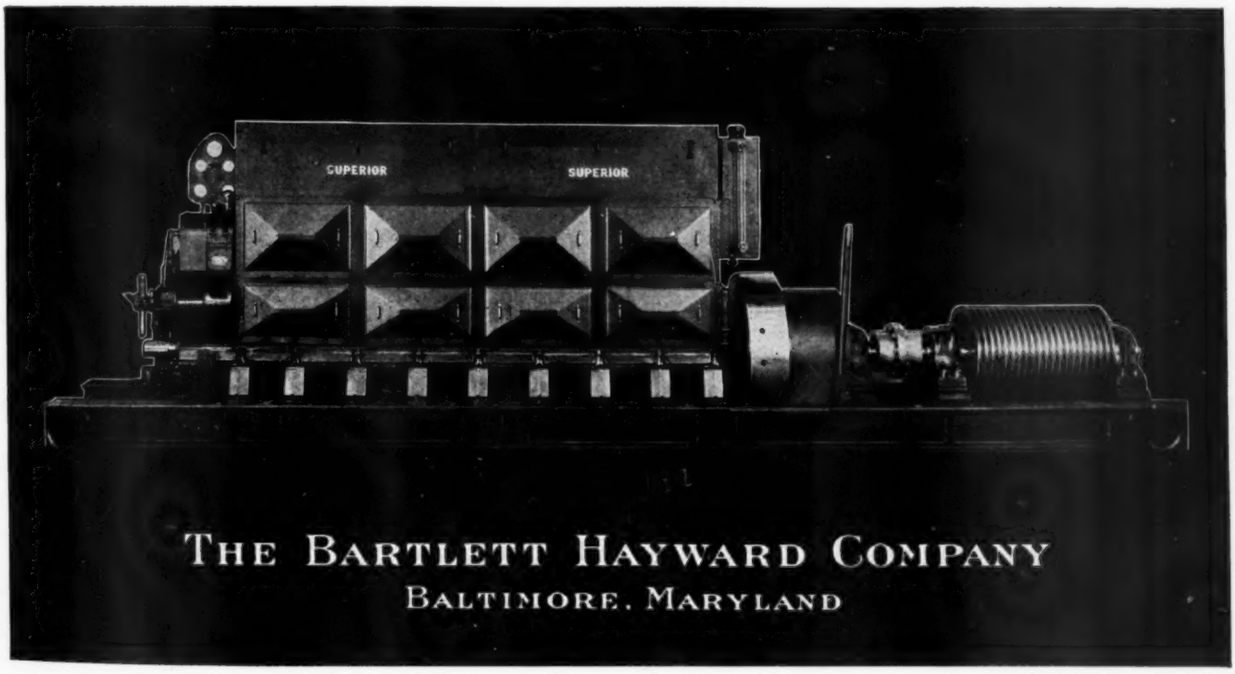


ing employed. This problem of efficient operation of a gas transmission system is now recognized as one of utmost importance. Not so many years ago the initial cost of the project was the primary consideration and the transmission or flow operation was not generally given the attention it deserved. Today the transmission superintendent is on the alert to discover the condition or arrangements that affect his duties as an able and efficient gas dispatcher whose principal responsibility is to maintain an adequate supply of gas in the transmission system. Many factors tend to oppose uninterrupted service to the city border station where distribution begins. So long as the transmission system is free of obstruction, and an adequate supply of gas at the proper pressure is available, no interruptions are expected; however, that is not always the condition and the trend is to construct and operate the system in a manner to avoid the reverses that are likely to occur. Among the factors often responsible for interruptions to flow is the accumulation of foreign matter. Usually this consists of water, oil, dirt, gas hydrates, or other foreign matter from internal pipe corrosion. Elimination of foreign matter from gas before it enters the distribution system has been receiving considerable thought within recent months. There are numerous improved scrubbers and drips on the market; however, care should be exercised in selecting the one of proper type and capacity. These scrubbers employ a liquid as the extraction medium and are constructed in accordance with the physical laws involved. There are various types of dry cleaners in use at the present time. The one generally accepted as the most efficient is designed to permit the gas to flow at low velocity through a filtering material wrapped around a cartridge, which is placed in a vertical position. The filtering medium is a cloth with nap surface (Canton flannel) and air mat. The air mat is of wood pulp tissue similar to filter paper, but loosely constructed. Three layers of 6-ply generally are used.

Dehydration[1] of gas is becoming more general to assure its proper conditioning before entering the transmission system. Several methods have been developed with varying degrees of success. The cooling tower design, the refrigerating process, and the calcium chloride system are most generally employed. The method selected depends on pressure and temperature conditions at the location where it is to be installed.

Internal corrosion is a problem receiving more attention than formerly. This is particularly true in systems that transport gas containing hydrogen sulphide and water vapors. After internal corrosion has advanced to a certain degree it often becomes a problem to remove the resulting deposits. The following method used on several miles of 20-in. line on the West Coast proved successful.[2] The pipe was cleaned in a 5-mile section between main line gate valves, each of which was equipped with 6-in. blow-down connections on either side. A section approximately 12 ft. long was cut from the pipe line approximately midway between the main line valves, and a special fitting for blowing the line installed at this point. This fitting was a piece of 20-in. pipe with a bulkhead one in. thick in the center, placed directly below the stack. On either side of the bulkhead a sloping baffle, made of ½-in. plate, extended from the top of the bulkhead to the bottom of the fitting and served to direct the flow up the stack. This type fitting made it possible to blow from both directions with one installation.

The section to be cleaned was blown down and the fitting installed, after which about three sacks of steel shavings were forced into the line through the blow-down connection at the main line valves. The valve on the blow-down connection at the main line valve was then closed and the main line valve opened as far as possible, forcing the cuttings through the line and out the fitting in the middle of the section.

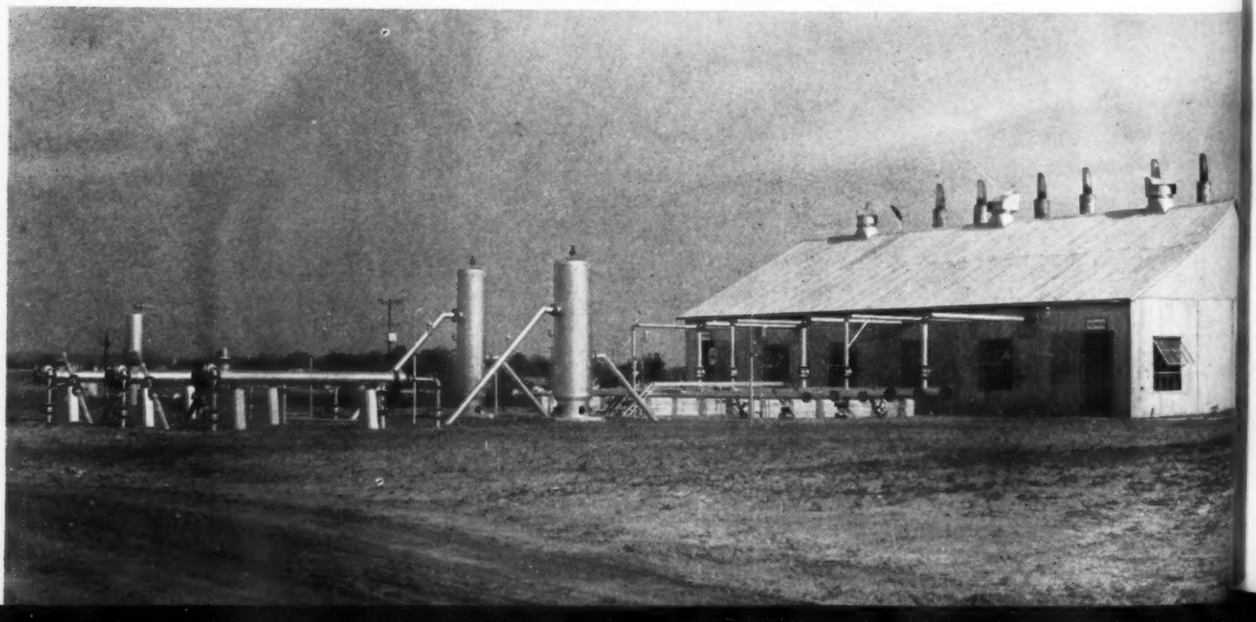
Pressure surveys were made before and after the operation to determine what friction loss had been eliminated.

There is a general trend by the management of most gas companies toward larger and better organized departments whose function it is to dispatch and control the flow of gas through the transmission lines. The control problem retarded the gas industry for a long time due to the lack of equipment and the general thought that this operation was only a necessary evil.

The chief function of the control department[3] is to coördinate the activities of the various departments, such as production, distribution, measurement, etc. In the control department office of one gas company is a large map upon which are shown the markets supplied, transmission lines, compressor stations, regulator stations, check valves, gate valves, and connections. It is mounted on the wall in a manner to permit the use of pins to indicate the position of gate valves; whether open, closed, or partly closed. Other size pins indicate lines out of service, etc. In this manner the dispatcher has a picture of the transmission system that will guide him in giving orders to branch offices in the field. Records are available for past performance, and curves are plotted showing, in percentage, the maximum

[1]References are given at the end of the article.

A modern gas compressor station in Fitts Field, Oklahoma



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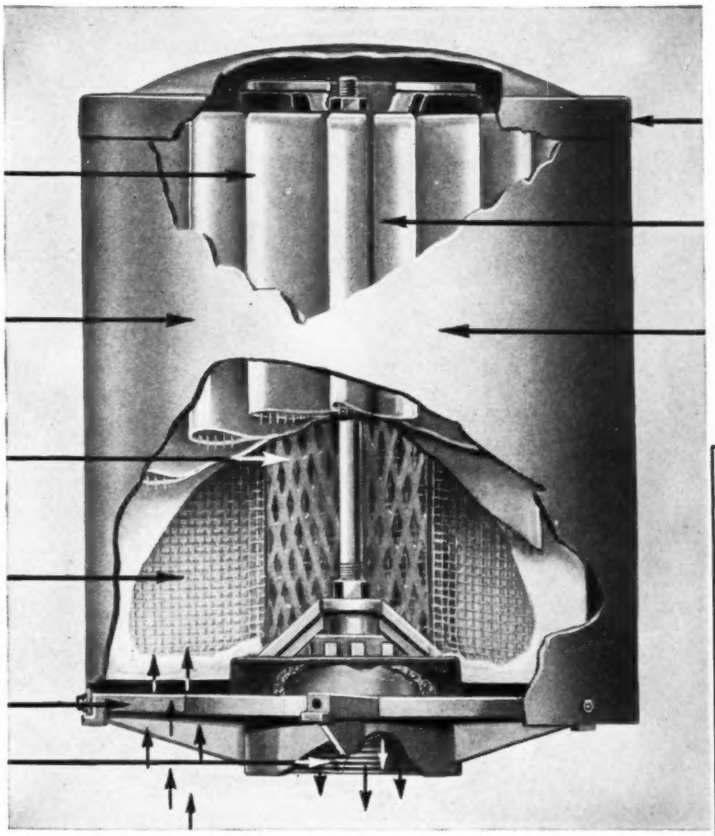

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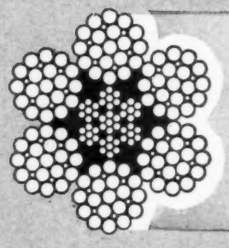

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daily requirement for any given temperature.

When additional gas is needed a request goes to the field branch office for the quantity desired and routing orders given. Wells from which the gas supply comes are classified in five groups.

The first group includes wells that it is necessary to keep on the line all the time, in order for them to "pay out."

The second group consists of offset wells to competitive fields.

The third group are wells offsetting the wells of producers from whom gas is purchased.

The fourth group consists of "first line" reserve wells.

The last group are wells in the field owned exclusively by the company and serve as a special reserve. Wells are "cut in" in the above order.

A complete card system is kept on the many regulators with reference to the regulator location, size, purpose, last pressure order, etc. Another card bears the name and telephone number of the local agent, number of customers, size of supply line, location of gate valves, and how it might be served from another source if the present one were interrupted. Other data also are carried, such as shut-offs that show the line involved, reason, number of customers affected, duration of shut-down, etc.

Many companies have set up a program of stress, testing periodically all major transmission lines. The lines usually are subjected to a pressure 25 percent in excess of the normal working pressure. Advance information is given the local field superintendent concerning the time, procedure, duration, etc., of the test. These tests can serve a two-fold purpose by (1) determining a safety factor and (2) by indicating leakage of a lesser degree than a rupture.

In recent years the trend has been to place more confidence in ability of the main transmission line to supply a constant, uninterrupted flow of gas to the terminals. The reason for this trend is that modern construction methods[4] have reduced the possibility of failures, and improved methods of quick repair have decreased the time any line is out of service.

Leaks caused by faulty fittings and pipe ruptures are most likely to occur during that period immediately following completion of the line and the end of the first rainy season. The soil then settles around the line, relieving it of initial strains. Several precautions can be taken when the transmission line is laid that will reduce the possibility of failures, such as providing slack loops, backfilling when the temperature is as near as possible to minimum ground temperature, casing pipe under highways, installation of expansion joints and anchorages at exposed joints, and giving proper attention to river crossings.

Another form of leakage or wastage in transmission lines is due to excessive blowing of drips. Drip valves should be choked, so as not to blow gas while the liquid is being drained.

There are countless forms of leakage, various tests and means of finding leaks, and many methods of repairing transmission line leakage. The leakage problem in transmission lines has been receiving much attention the past year. This might be attributed to the realization on the part of gas companies that there seems to be no limit to the expansion of gas markets; and conservation is being stressed more each year.

Compressor Stations

Though numerous new markets were opened to gas distribution the past year, some many miles from the source of supply, it was not found necessary to erect many booster stations. Increased pressure requirements necessary for the delivery of greater volumes were, in most cases, cared for by utilizing reserve well pressures, or obtaining the supply from fields where high operating pressures existed. The latter condition applies to the Lone Star Gas Company's line from Irving Junction to the Cayuga and Long Lake gas fields where rock pressures are 1500 lb. and 2100 lb., respectively. However, the largest project of the year, the Detroit line, necessitated the construction of several stations by the Panhandle Eastern Pipe Line Company to meet pressure requirements resulting from the additional load.

Several stations are under construction at the present time. Starting in the Texas Panhandle the stations will be in this order:

Sneed, Texas - - -	New 2600-hp. station
Liberal, Kansas - -	New 2000-hp. addition, making a total of 7000-hp. in this station
Greensburg, Kansas -	New 3900-hp. station
Haven, Kansas - -	New 3900-hp. station
Olpe, Kansas - - -	New 3900-hp. station
Louisburg, Kansas -	Existing 5000-hp. sta.
Houstonia, Missouri -	New 5200-hp. station
Centralia, Missouri -	New 3900-hp. station
Pleasant Hill, Illinois	New 2600-hp. station

Other proposed stations will be at Tuscola, Illinois, and Montezuma and Zionsville, Indiana.

The basic principle of operation and the design of large compressor units have not shown much recent change.

Making a bell-hole joint on a 22-in. gas line in California

The manufacturer continues his efforts to improve and perfect the accepted prime movers that are in general use. Major changes are not so evident but many minor alterations in design and materials have aided in efficiency of operation.

There is a general trend toward more compact and lighter vertical units. These engines require less space, are more easily installed, are more easily repaired because of the accessibility of parts, and vibration is reduced to a minimum. Provisions are now made that enable the operator to switch fuels, gas or oil, with only minor changes in the equipment. The overall efficiency of the horizontal engine has increased. This is partly due to changes made in the valves and cylinders. Several improvements are offered in the larger 4-cycle units. The ignition has been simplified, lubrication is more positive, the cooling system more efficient, and better valve metal has resulted in less trouble from this source. The research departments of the various engine companies have experimented and tested the several metals and alloys that comprise the finished unit, rendering the engines more suitable and reliable.

Fabricating river headers for a large-diameter gas line

At times, due to operating conditions at certain stations, changes have been made in the original equipment. An example of this occurred when the seven compressors at the Pacific Gas and Electric Company's Kettleman Hills Station[5] were equipped with larger cylinders and four clearance pockets in the outboard end.

Originally, with cylinders of 11½ in. diameter and an inlet pressure of 385 lb. gauge at the compressor, the six units were capable of delivering 210,000,000 cu. ft. of gas per day at 450 lb. discharge pressure. The larger 12½-in. cylinders and clearance pockets are capable of delivering 227,500,000 cu. ft. of gas per day at 385 lb. intake and 500 lb. discharge pressure. By increasing the capacity the station has two spare units instead of one.

The design and construction of compressor station buildings erected more recently and those under construction retain all the operating advantages of the older stations, as well as incorporating new ideas of efficiency and safety.

The latest compressor stations are of the type with which all are familar. Frameworks are of steel with covering of corrugated galvanized iron asbestos, and an abundance of steel sash and doors. No major changes in materials or construction ideas have been witnessed the past year or so, but much thought and experimenting has been done in stations in the so-called "Dust Bowl." Due to operating difficulties encountered in this dust area, where there are many stations, the seriousness of the situation was soon realized and the solution sought, resulting in many companies providing respiratory devices or dust masks for the protection of their employees. The most efficient type employs filter mediums of paper, paper fiber, sponge felt, or wool cloth. The camp dwellings recently built in this region are constructed to eliminate this dust menace as much as possible. Semiplastic calking[6] compound fillets are applied around doors and window casings inside and outside and at the foundation, walls, and woodwork to afford additional protection against the infiltration of dust-laden air.

It is a difficult problem to exclude the dust from a compressor plant because of the many door, window, and other ventilating openings. Once this dust enters the building the engines "breath" it into their crankcases, mixing with bearing oil, completely overloading oil filters, mixing with the oil whereby it is carried to the bearings to damage them. Dust enters oil supply tanks, measures, grease cans, to reach ultimately some part of the machinery. Electric generators and motors are damaged unless totally enclosed. Most companies have fastened well-fitted canvas covers over the tail guides of the engines. Motors now installed are of the enclosed type. In an effort partially to eliminate this condition some companies have resorted to a plastic sealing compound for joints and cracks. Others solder the longitudinal joints in the corrugated iron and fill other joints with strips of oil felt. Larger openings are filled with asbestos fiber wetted in oil.

The atmospheric-type cooling towers catch much dust, which is converted to mud and eventually deposited in cooling pockets. The solution of this condition seems to be the continuous dumping of the muddy water and cleaning of the basin or the clarification of part of the water by a sand filter.

Intake air for the gas engines is generally conditioned by some filter medium or scrubber arrangement. A circular panel containing oil-soaked filtering material is being used in some stations. In other stations the air passes through agitated oil and is then filtered. When considering either of the above methods some thought must be given the filter capacity, flow restriction, efficiency, and service requirements.

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5"Clearance Pockets for Transmission Line Compressors." By H. J. Smith, *Gas*, August, 1936.

6"Compressor Station Problems in the Dust Bowl Area." By R. F. Powers, A.G.A., Dallas, May, 1936.

Construction scene on recently completed 22-in. gas line of Michigan Gas Transmission Corporation to Detroit, linking the latter with producing wells in the Texas Panhandle

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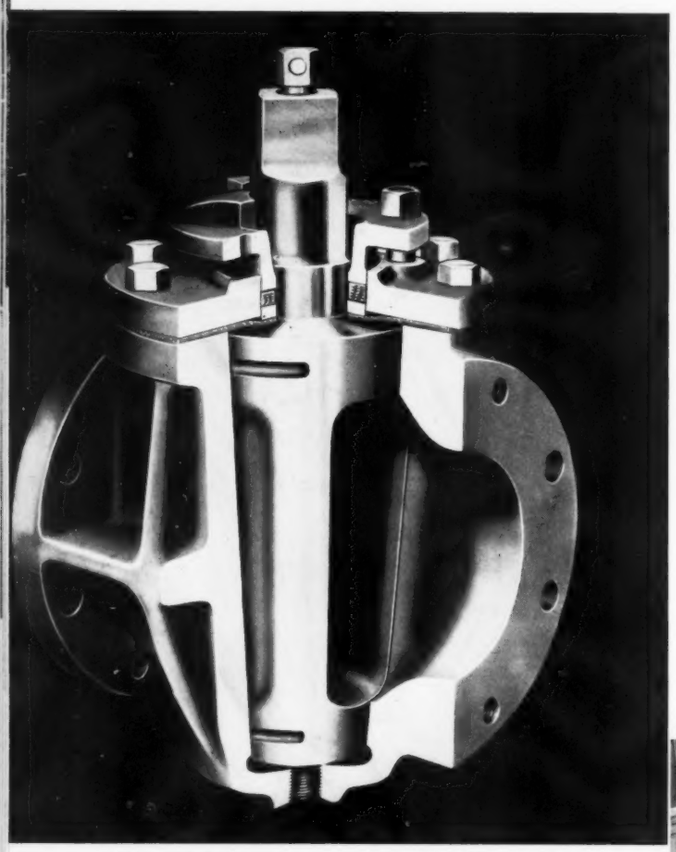

Above cut shows cut-away view of Emco-Nordstrom. Photo to right shows manifold in a Texas gasoline plant equipped with 8" and 10" Nordstroms on suction lines and 4" and 6" Nordstroms on discharge lines.

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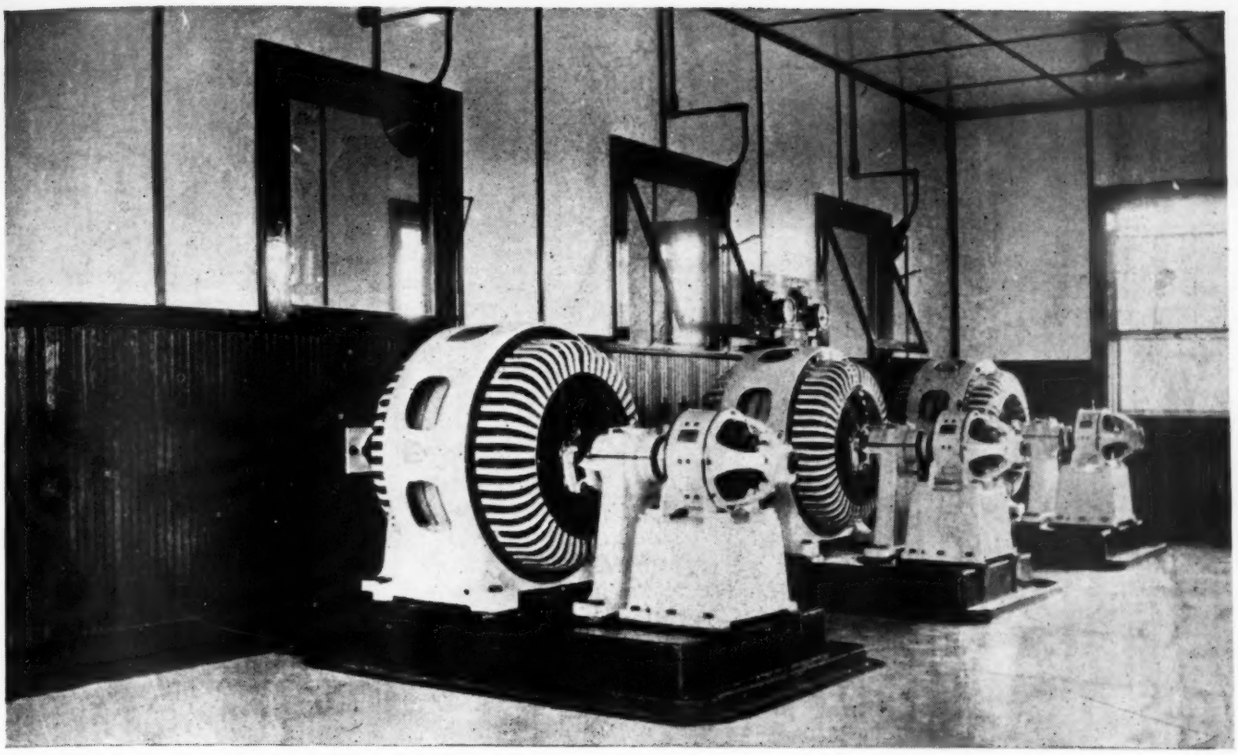


Open type 400-hp., 1800-r.p.m. synchronous motors used on Illinois pipe line. This installation was one of the early major pipe line projects employing electric motors direct-connected to centrifugal pumps

Pipe Line Transportation Systems • and Electric Power •

By

W. C. DREYER*

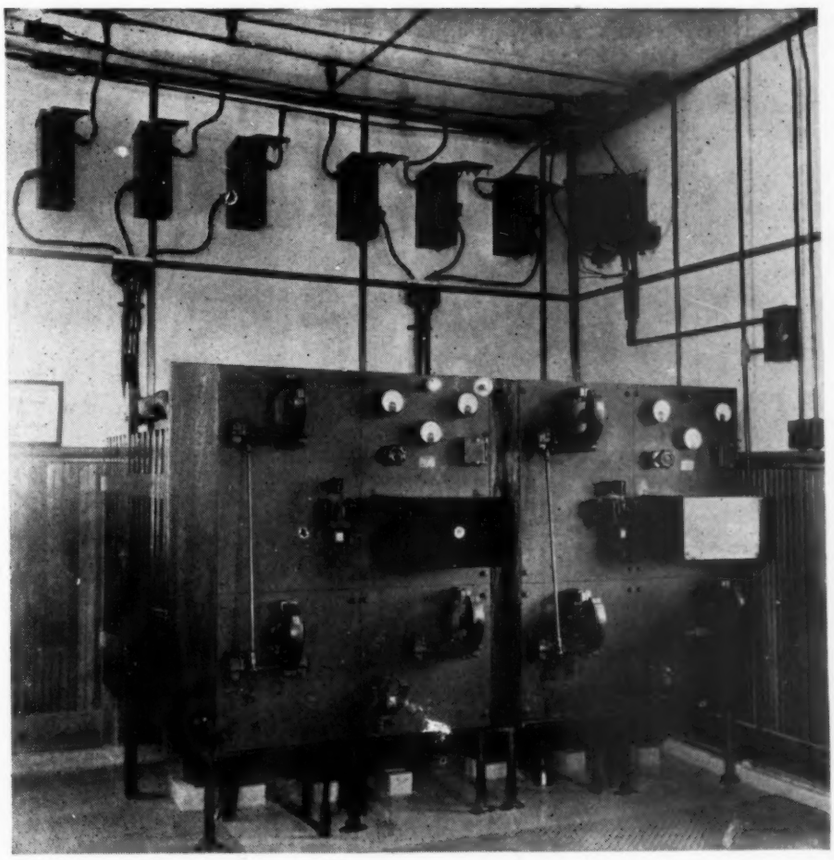
A review of some of the important developments in the application of electric power and equipment to pipe line operation

ELECTRICITY and electrical equipment are of ever-increasing importance to the pipe line branch of the petroleum industry. It has found many applications — welding of new pipe lines, reconditioning old lines, as a means of cathodic protection on underground structures, and as a source of power for driving reciprocating and rotating machinery. The electric motor also is suitable for driving auxiliary equipment in pipe line stations.

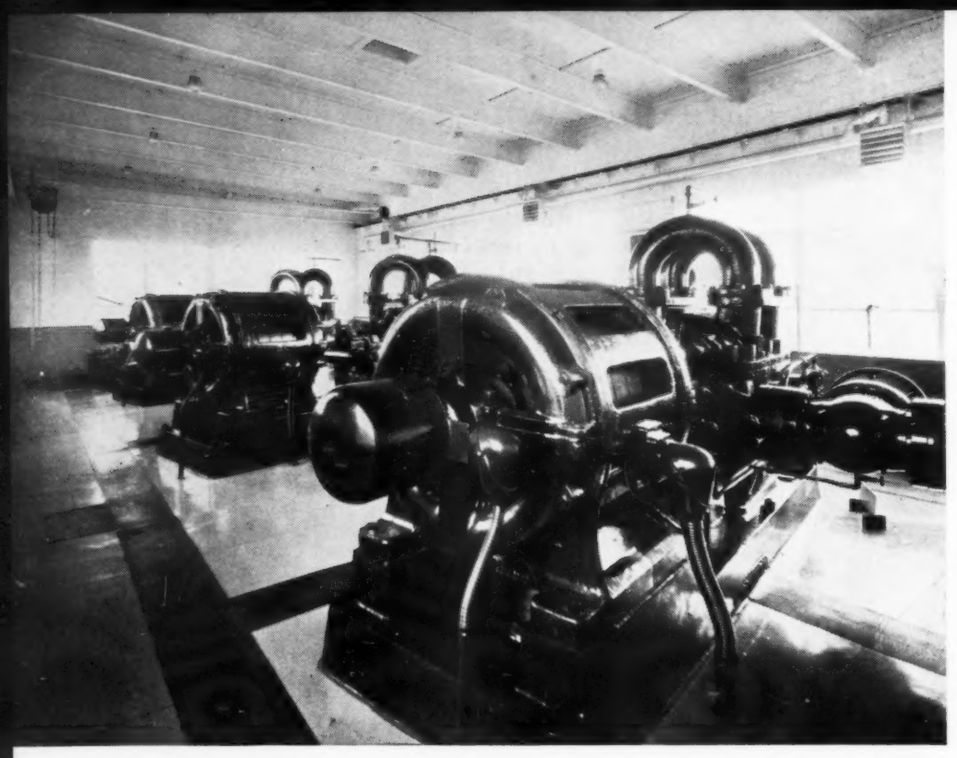
Oil Pipe Lines

Since the introduction of centrifugal pumps suitable for pipe line work electric power has come into

*Westinghouse Electric and Manufacturing Co.



Open unprotected control for the 400-hp. motors on Illinois pipe line



800-hp., 1800-r.p.m. synchonous motors with protected collector rings, installed on Texas Empire pipe line

wide use as a drive for oil line pumping stations. About 1924, centrifugal pumps were developed capable of handling large volumes of oil at high pressures and with suitable efficiency. High-speed electric motors have become standard for driving high-speed centrifugal pumps in pipe line stations. The low installation costs of pumping units of this type are such that the difference in overhead costs usually offsets the greater cost of power.

Electric motors of the type suitable for pipe line drives have a constant speed characteristic. Where the throughput of the line varies, it has been necessary to obtain variation in line capacity to shut down units or stations or install a small unit driven by a variable-speed motor at each station.

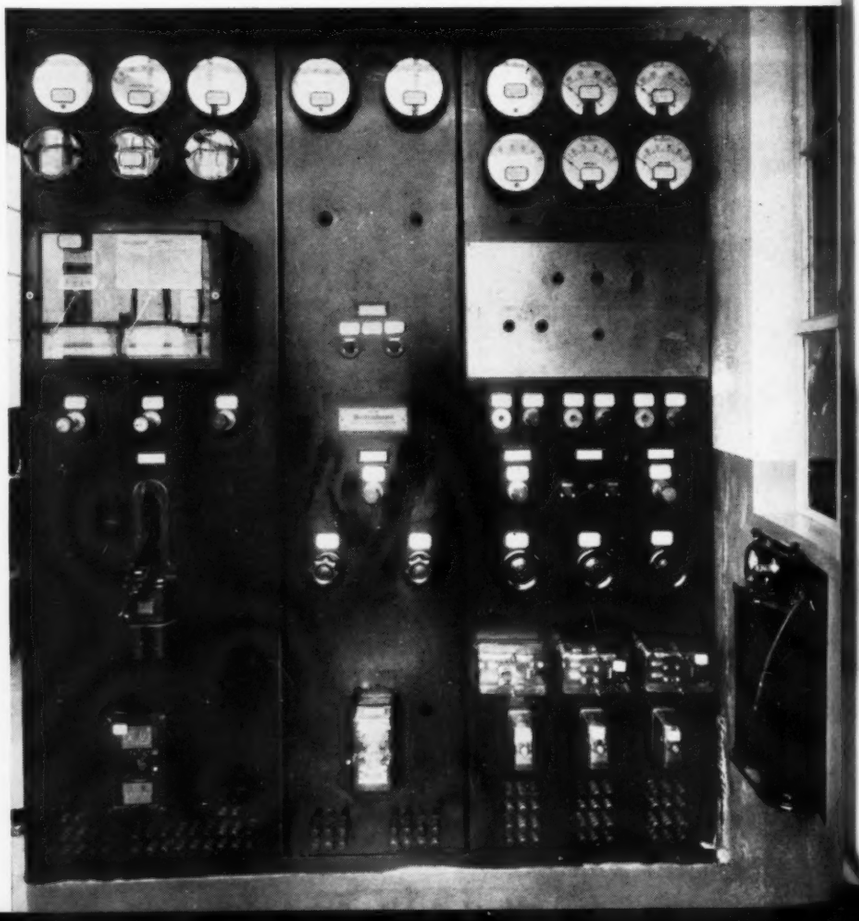
Numerous types of variable-speed a-c. electric drives have been considered for pipe line work, but none now available is entirely suitable. The standard wound rotor motor probably is the most satisfactory, although the speed reduction is obtained by sacrificing power. For centrifugal pump drives this power loss is not so serious, since the torque required to drive the pump drops off in relation to the square of the speed. Electrical manufacturers have been working on variable speed motors employing electronic tubes. Such motors are entirely feasible and will be used when the art of tube manufacture makes tube life longer and tube replacement cost less.

Almost all motors in use today for driving main line pipe line pumps are either of the synchronous or squirrel cage type. Synchronous motors have the advantage of being slightly higher in efficiency, and have a high inherent factor. Where purchased power is billed on a power factor basis the installation of synchronous motors can be justified and their additional cost usually will be amortized in one year by the saving in power bill. The outstanding feature of the squirrel cage motor is its simplicity and ruggedness. Having no arcing parts the squirrel cage motor is generally considered safe enough to use in pipe line stations without complete enclosure. The danger of such a motor igniting vapors is possible only in event of winding failure or in event of a bearing failing to the extent of allowing the rotor to strike the stator. The squirrel cage motor and the synchronous motor with its collector rings in an explosion proof housing are both considered safe enough for pipe line work.

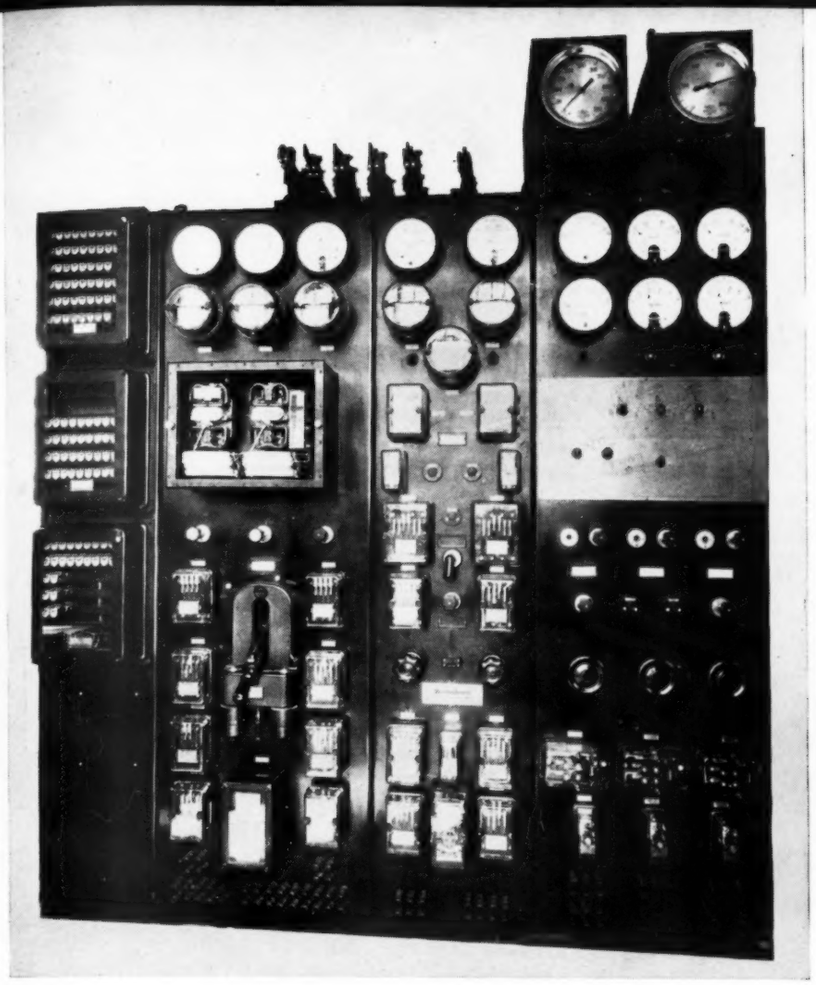
The added investment necessary to install complete explosion-resisting equipment is justified only when there is great hazard to life and property or when the apparatus driven is of prime importance to the operation of the complete system.

Gasoline Pipe Lines

Trunk gasoline pipe line systems are in their infancy. It is predicted that many more gasoline lines will be constructed in the future. The gasoline line differs somewhat from the oil line. In operating a gasoline line it is customary to pump through the line batches of different blending agents, these being blended at the gasoline terminals to fill specific orders. Pumping in this way makes it undesirable



Control for 800-hp. motors on Texas Empire pipe line



Control for 800-hp. motors on Texas Empire line, showing addition to the panel for remote supervision control

to use surge tanks on the line because of mixing products. Elimination of surge tanks requires that all stations on the line pump continuously at the same rate and favors the use of centrifugal pumps. Shutting down of any one unit reduces the capacity of the entire line. The electric motor is particularly well adapted to such an application, and is an ideal drive for centrifugal pumps. It lends itself admirably to automatic and supervisory control. Automatic protective devices are particularly desirable for shutting down gasoline pumps in case of emergency. From an operating standpoint, being able to control all stations along the line simultaneously is important. It is much more desirable to control all stations from a dispatcher's office by means of supervisory control than to have each station controlled individually. Supervisory control has been successfully tried out, and one installation on an oil line station at Sand Springs, Oklahoma, has been in operation since 1930, but no lines are yet completely controlled in this manner.

Auxiliary Generators

There is considerable electrical equipment used for general purposes on every pipe line. Stations with pumps driven by other than electric motors require generating equipment for lighting and miscellaneous uses. These generators either are small units, belt-driven from the main engines, or small separate engine generator sets. They are designed to carry the required load for the speed range likely to be encountered in normal operation of the primary pumping units.

Auxiliary generators provide power for station lighting and for domestic use at the station camp; in addition water pumps, sump pumps, oil centrifuges and similar auxiliary motor-driven equipment may be supplied power by this generator.

D-C. Source for Cathodic Protection

Where power lines are economically available, d-c. power for the electrical protection of pipe lines against soil corrosion may be obtained by converting a-c. power to d-c. power with rectifier units. The difficulty is that many locations are remote from power lines and the load involved does not warrant long line extensions. D-C. power may be provided at such locations by wind-powered generators, engine-driven generators, and by other methods. Wind-driven generators are self-contained units fastened to a revolving mounting and equipped with a governor to maintain fairly constant speed. Engine-driven units also are self-contained, slow-speed sets with large lubricating oil capacity. On gas lines they take fuel from the line. Such units often operate a month at a time without attention.

Explosion-proof, 300-hp., 3550-r.p.m., squirrel cage induction motor driving a gasoline pump in California

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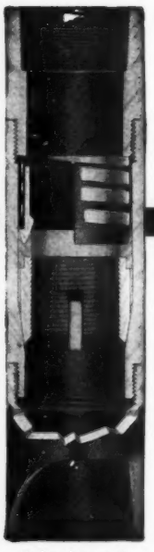

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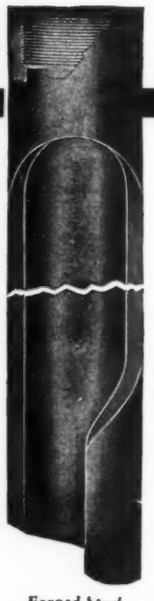

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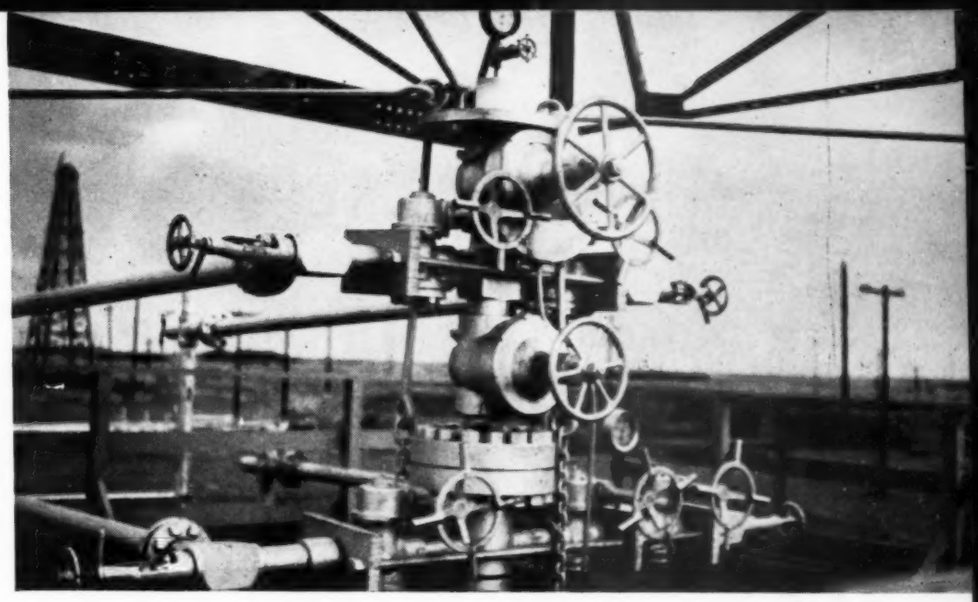

A modern Christmas tree on a California well

Many interesting developments in new drilling and production methods—Prospects bright for increased activity

Review of Drilling and Production Practice in California

By WALLACE A. SAWDON
Petroleum Engineer, Los Angeles

THE past year has seen some interesting developments in California's oil situation. Although no widely-heralded fields have been discovered, the productive position of the industry certainly has been improved; and this, in spite of the fact that the number of active drilling wells has not increased during the period. Drilling and production methods have continued their forward advance, and as has been reiterated during the past four or five years, the industry is still going scientific. There are a number of points relative to each phase of drilling and production that are of particular interest, however, and while no conclusions will be made on the economics of oil production in the state, this factor, combined with marketing influences, can be seen to be of vital importance at the present time.

A little over a year ago proration came into the limelight and voluntary curtailment of production was given some hard jolts. As clearly indicated in Fig. 1, production increased until a volume of 680,000 bbl. a day was reached. It then dropped rapidly and has been around 575,000 bbl. daily for the past six months. This, of course, is considerably more than the less than 500,000 bbl. that had been maintained for about four years.

The market and price structure naturally have influenced the situation. Stocks of crude oil and refined products in Pacific Coast territory had declined from about 190,000,000 bbl. in 1930 to a little over 118,000,000 by the end of July, 1935. They then increased to more than 136,000,000 bbl. in February, 1936, but have now declined to 134,000,000 barrels. This closely approximates the production curve for the past year, with seasonal demand providing a lag in stock increases during the summer months.

Available data indicate that no fields approaching the magnitude of Kettleman Hills, Long Beach, Santa Fe Springs, or the extensive San Joaquin Valley areas have been discovered. Yet the opening of new fields, the extension of old ones, and the developmnt of deeper sands have increased the future reserves of the state. The comparison of a recent estimate of California reserves with one made January 1, 1935, is given in Fig. 2. Though the increase is but 13 percent over the reserves of 18 months ago, the oil taken from the ground during that period has been offset and considerably more than another year's supply added.

The estimated normal daily potential on which allowable production is based has been decreased slightly during the past year and is now slightly more than 1,000,000 bbl. a day. With any considerable increase in production, the capacity to produce may be reached, since potentials often fall rapidly under producing conditions. The discovery of new fields in all probability will offset such a contingency; and the more rapid development of present discovered areas and deeper zones can be made to alleviate it to some extent.

The prospect of new discoveries is just as uncertain as it always has been. California has reached a peak several times that made earlier peaks seem small in comparison. During the highly productive year of 1929 the daily average was about 800,000 bbl., which is considerably less than the present estimated normal potential. A few good fields could maintain that figure for quite some time, and with the experience gained by the industry, curtailment could keep production within bounds to meet demands and preserve a higher ultimate yield.

Geophysical exploration is being put to greater use and may be the means of locating new fields. Geophysical methods also are being improved and more reliable data procured by the new methods. The San Joaquin Valley is receiving increased attention at the present time, since prospects seem favorable along the eastern side. Extending north of Kettleman and Coalinga there are extensive possible productive areas. Deep wildcatting undoubtedly will be necessary on a scale more extensive than at present, but good geophysical work should aid materially in making it most effective.

DRILLING

No depth records have been broken in California during the past year but deep drilling technique has been advanced to a considerable degree by the completion, with little difficulty, of wells to depths greater than 8000 feet. Probably the most valuable data have been obtained in the running of long strings of casing where two records were established at Kettleman Hills. One record was set when an 8¼-in.

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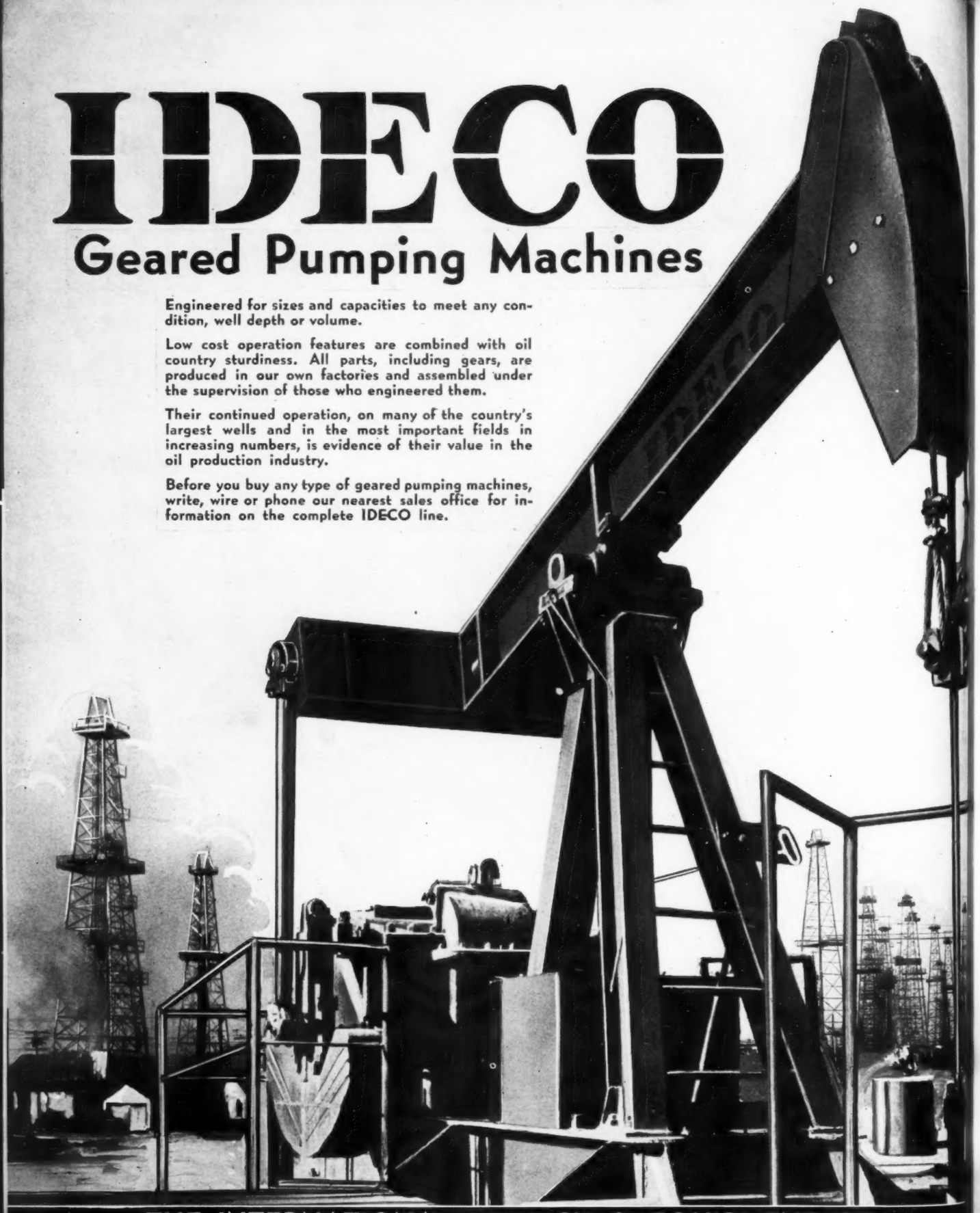

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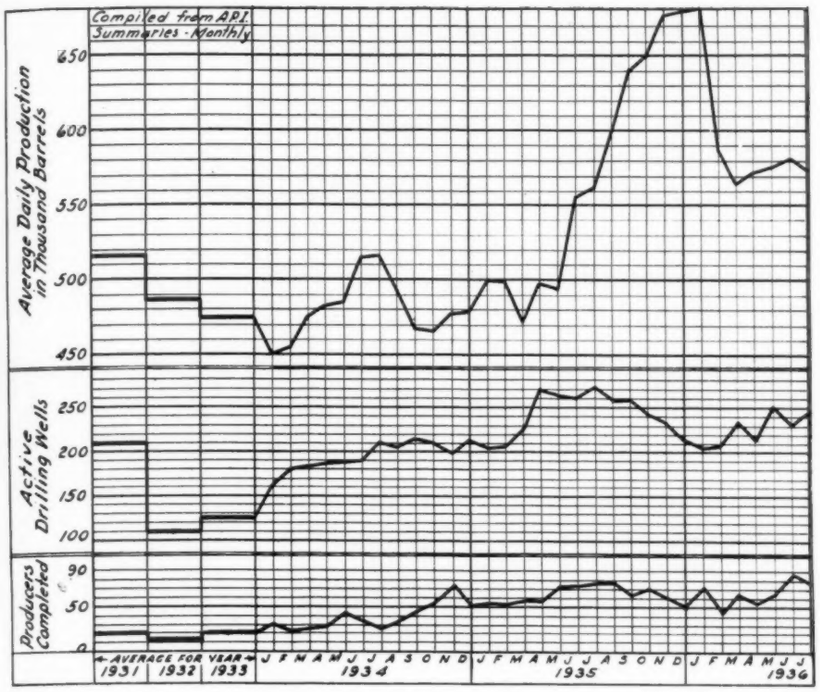


Fig. 1. Statistics of drilling and production—California

string was run and cemented at 9081 ft., the other when a 6⅝-in. string was cemented at 10,815 ft., exceeding the two-mile mark. Pipe design and metallurgy have shown their adaptability to providing for deep-well conditions and, combined with proper handling and the use of good floating-in equipment, have demonstrated that wells drilled to a depth greater than 10,000 ft. can be cased adequately.

Successful perforation of casing at great depth also has been proved feasible in the Kettleman well mentioned above. It was decided to test the formations above the 10,815 ft. depth where the 6⅝-in. string was cemented, so a gun perforator was lubricated into the well under pressure and perforations made from 10,760 ft. up. During this work a heavy flow of salt water came from below and was shut off by setting a cement retainer as a heaving plug at 10,790 feet. Such operations, especially under the adverse conditions encountered, show that depths that may be necessary in the near future can be drilled efficiently with existing equipment.

Floating-in of casing relieves the strain on surface equipment, and the floating-in devices employed on long strings of casing have proved equal to the severe requirements demanded. Portability in drawworks and prime movers for deep drilling has been the outstanding development during the year. A structural steel base for these heaviest parts of the rig now provide almost complete salvage for everything above the concrete foundation on which it rests. Although this assembly is not so portable as the units mounted on trucks or tractors that have been used for drilling to depths of about 4000 ft., they do save in rigging-up time, are easily transported, and provide economies in drilling deep wells.

The first direct-reversing Diesel engine drive for rotary drilling was installed at Ventura Avenue field for a test to be made below 9000 feet. This apparatus has been given considerable study and from the results obtained the adaptability of direct-connected Diesels to meet certain conditions may be developed.

Speed of rotation in drilling evidently is on the increase. The higher table speeds are accompanied by less weight on the bit and it has been concluded by many operators that faster and straighter drilling will result from this practice. The tachometer consequently has come into wider use during the past year, although several companies much earlier had decided that constant speed as controlled by the tachometer was a distinct advantage and that the speed should be much faster than previously used. No specific rules can be set down to cover all drilling conditions; but there seems to be a general trend toward 150 r.p.m. as an average, and one or two companies favor even greater speed under all conditions.

The study of mud fortunately is still being carried on, but unfortunately it is doubtful if all the knowledge gained through experimental work and by examining the action of mud under subsurface conditions is applied to full advantage in field work. The heavier native muds in California are composed mainly of inert solids, but the lighter ones have considerable colloidal material. These

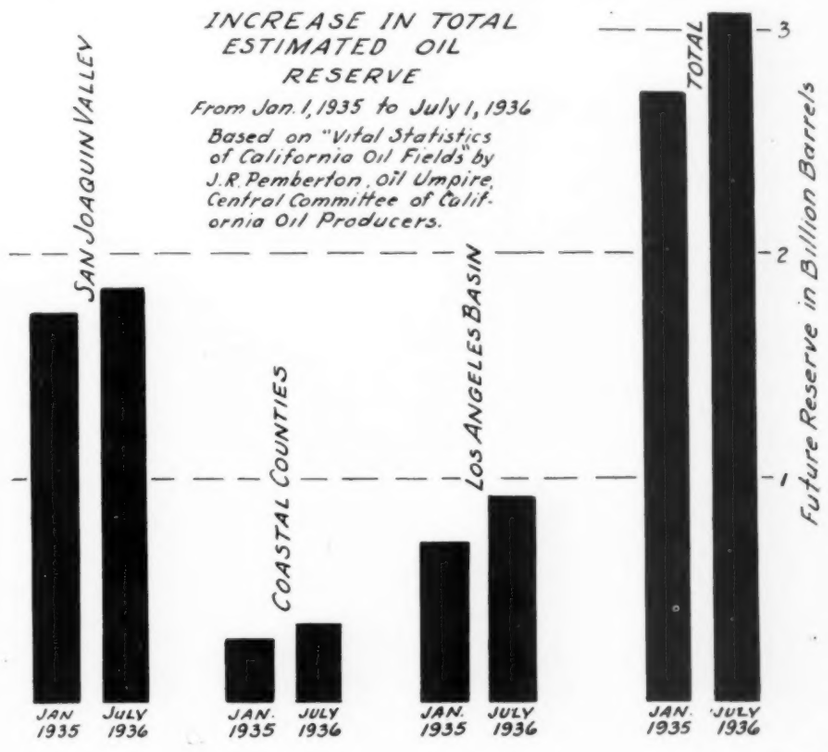
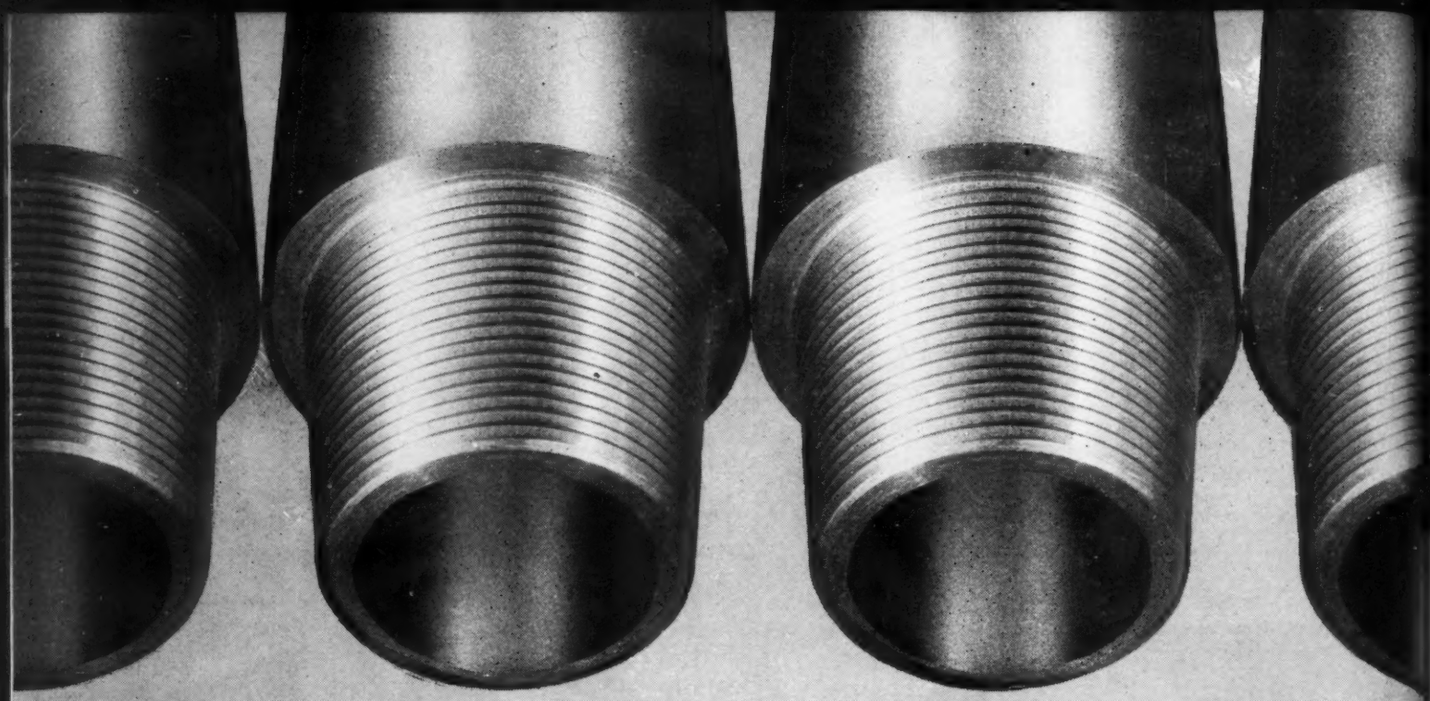
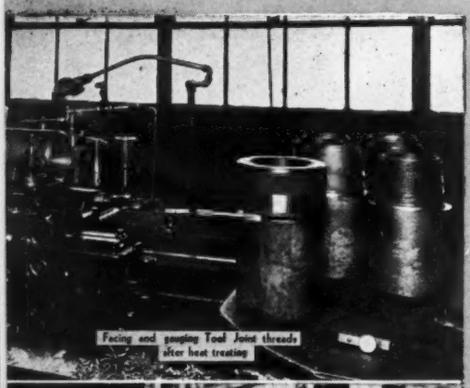


Fig. 2. Increase in California oil reserves by districts

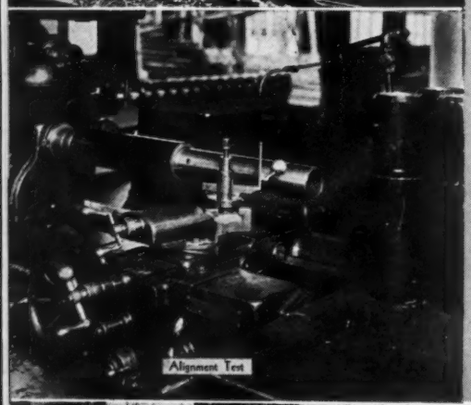


THE UNIFORMITY OF

REED TOOL JOINTS



Facing and gauging Tool Joint threads after heat treating



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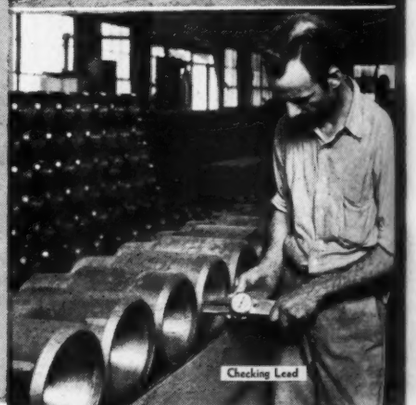
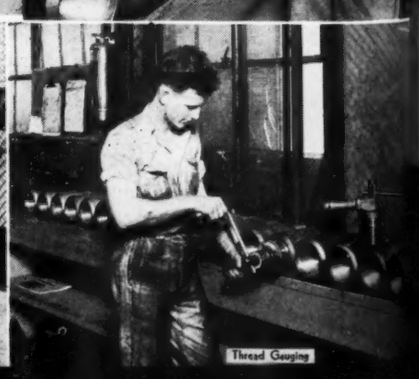
Thread Inspection



Checking Lead

Checking Taper

Brinell Test



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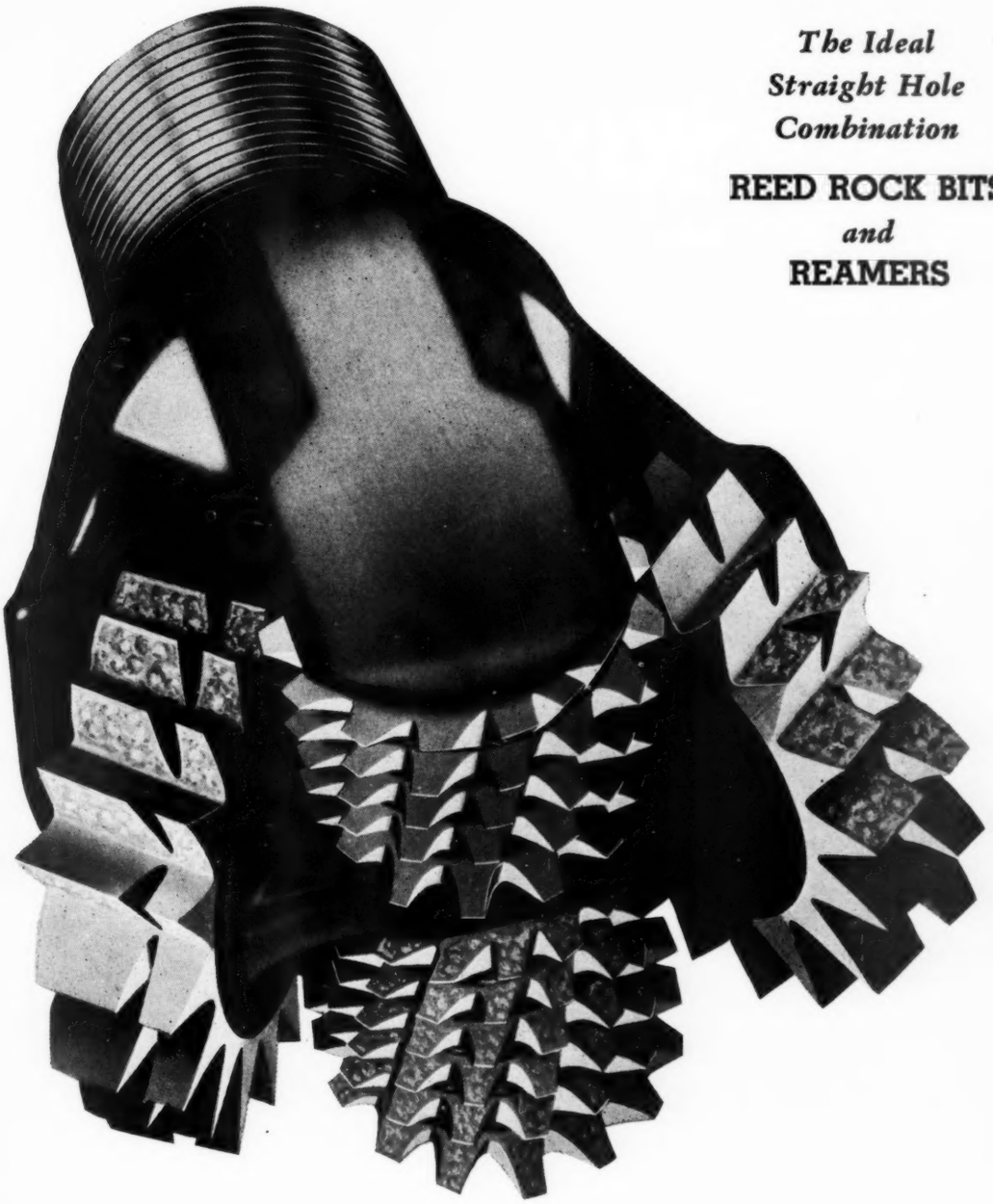

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lighter muds probably are well able to hold solids in suspension, but the functions of the mud fluid also must include a sealing action on the walls of the hole.

Considerable tests are being made by means of the filter press, whereby the down-hole conditions are simulated as nearly as possible. In such tests, even the lighter native muds are shown to require additional colloids to make them fully efficient. Viscosity tests, while of great value, will not always disclose the true colloidal condition of the mud, since a thick mixture lean in colloids may have a high viscosity. Greater advantage is being taken of the test car for property determinations of the mud at the well, but there is still much to be desired in co-ordinating mud control with laboratory findings.

For lost circulation, applications of fibrous material combined with a colloidal admixture recently have been found effective in several wells in Poso Creek, in the depleted zone at Signal Hill, and in several other fields. Lost circulation is, of course, a specific problem the solution of which is contingent upon the conditions encountered, but the introduction of the fibrous material may aid materially in sealing certain types of formations found in California. The material here found effective is a combination of short and long fibers and is usually mixed in the proportion of 12 lb. per bbl. of mud.

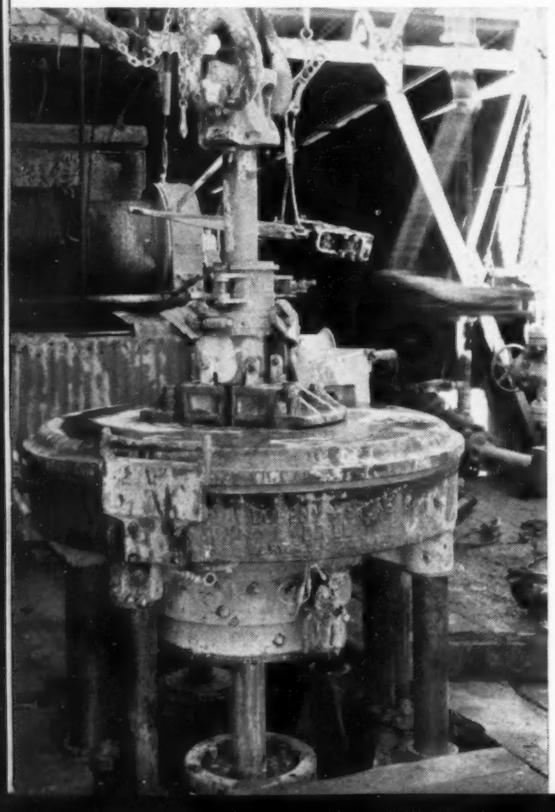
Although pressure drilling is used in several fields, considerable attention has been centered on completion with oil under pressure. In a well at Kettleman Hills so completed recently the oil was placed in the system and circulated at a rate of about 100 bbl. per hour. This circulating fluid was gasified with 650,000 cu. ft. of gas per day introduced at a pressure of from 1150 to 1200 lb. per sq. inch. The pump pressure in handling the oil was maintained at 1000 lb. and back-pressure maintained at 100 pounds.

The pressure-drilling equipment included the hydraulic rotary table as shown in an accompanying illustration and the drill pipe used was 3½-in. flush joint. A steel rotary hose of improved design also was employed. This hose is lighter in weight than the earlier types of steel hose and is particularly adaptable to high pressures without danger of leakage around the joints.

Electrical logging has established definitely its place in the drilling of rotary wells and, with the advancement in operation of instruments and the interpretation of curves furnished, this method of procuring sub-surface information has been employed in many particular instances. Most of the electrical logging is being done in open hole, but a later method introduced during the past year is designed to provide formation data in cased holes. One curve (see accompanying illustration) is plotted from information obtained by this method and from it conclusions reached regarding the strata.

The evident advantages of electrical logging in cased hole are to provide a means of locating productive strata that have been overlooked without previous knowledge of its existence, and to aid in repair work. The value of such information is obvious, both where it is suspected that possible production may lie behind casing, and where information subsequent to running the casing has been procured from other sources to indicate such production may have been overlooked.

While the point of entry of water may be located with considerable accuracy preliminary to repair work, the true source of the water may not be known, since many logs, especially where wells have been drilled with definite objectives or under stress of time, will not give sufficient data to disclose the offending stratum. In repairing a well, a knowledge of the position of the water-bearing zones and the character of the beds above and below will provide a means for intelligent procedure.



The hydraulic table, together with other pressure equipment as shown, is used for completion of wells in Kettleman Hills with oil under controlled pressure

Electrical thermometer recently introduced in California for making temperature surveys in wells

About six months ago an electrical thermometer recently developed was introduced to California drilling practice for continuously recording the temperature in the well. By means of this apparatus formations have been logged through casing by observing the speed of exchanges of heat between the formations and a cold fluid filling the hole. The logs obtained have correlated closely with the electrical logs of the formations made in open hole.

Other uses to which this thermometer have been put include locating the top of cement behind casing by observing the increase in temperature due to the setting of the cement, and the locating of gas sands in open hole by observing the cooling effect due to the expansion of gas.

Directional drilling—both legal and illegal—has been somewhat in the limelight during the year. Several cases of wells accepted as evidence in reaching trespass have been tried and surveys of a decision. These cases have established the efficacy of controlled directional drilling of wells and the accuracy of the oriented surveys made to obtain evidence.

The possibilities of directional drilling for legal spacing of wells on the sand is of far more importance and the advantages attending this method have become better recognized. The tidelands at Elwood and Rincon have been so drilled to some extent for several years, with an attendant economy of operation. A wider application of directional drilling under other conditions probably will develop in the near future since certain factors often

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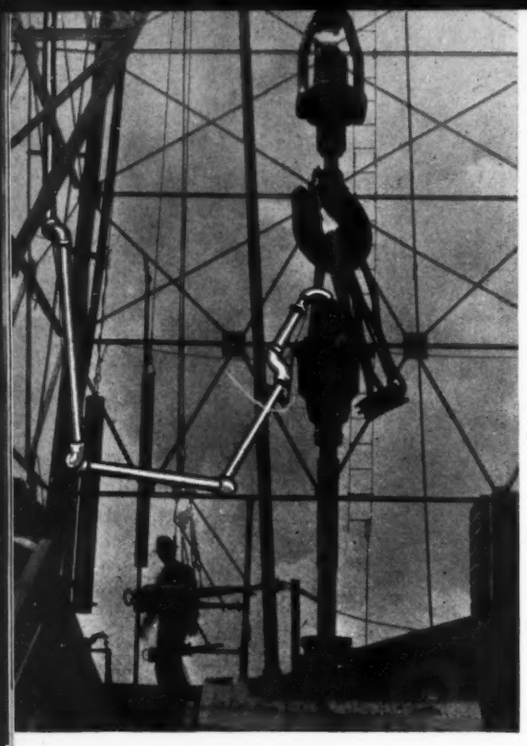


Light-weight steel rotary hose has been found particularly adaptable to drilling-in with oil on this well in Kettleman Hills

make it economical to have the surface location at one point and the sand penetrated at another, all on the same lease.

Consolidation of surface equipment for several wells has not yet been given the attention it deserves, but with the data now available as to how accurately the subsurface course of wells can be directed, a greater use of directional drilling may result. A hole properly controlled for direction will not interfere with the running of pipe or with production equipment after the well stops flowing. Sharp deviations or "doglegs" in a straight hole may cause more trouble than a well drilled to a point below ground some distance off vertical from the derrick floor.

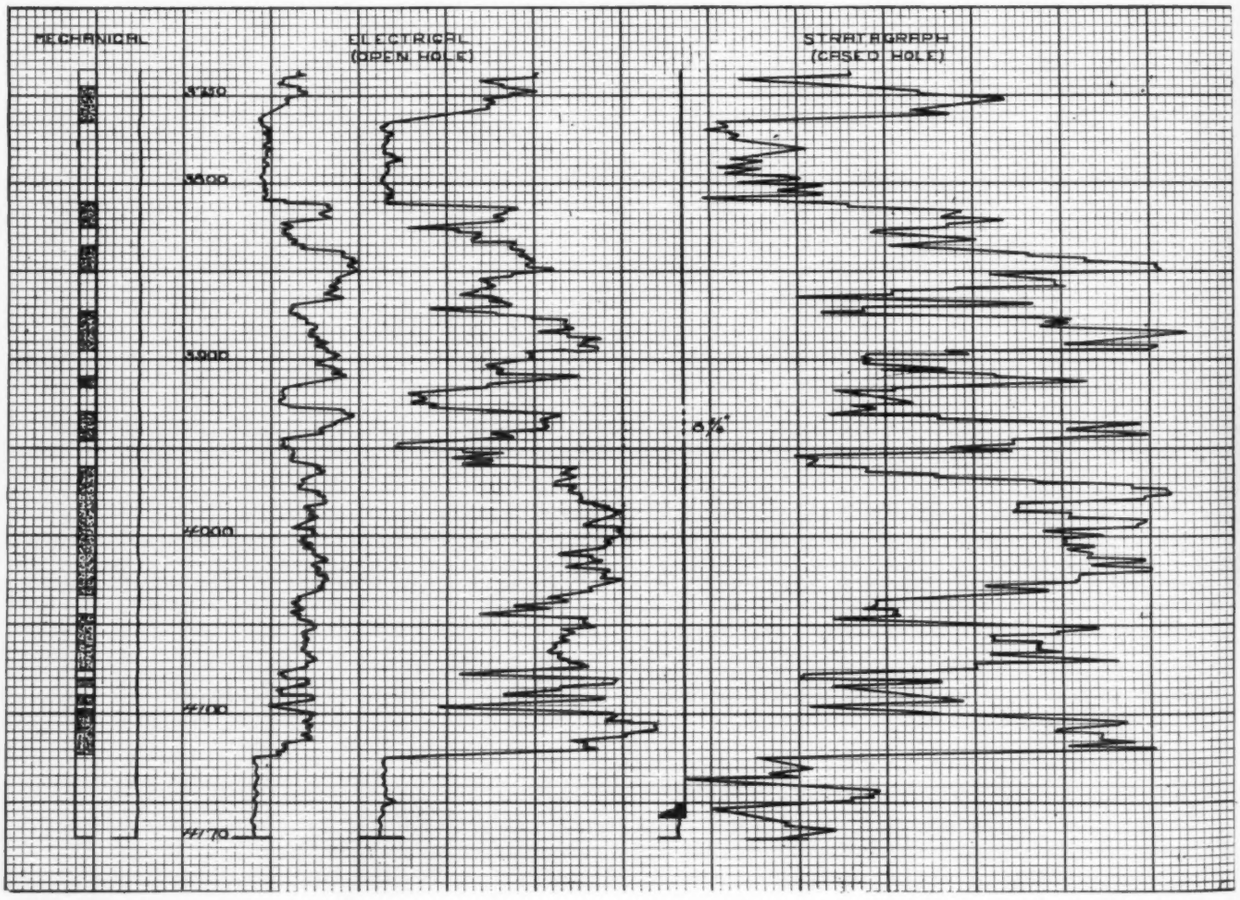
Recent developments in instruments and equipment also include fishing. In one of the wells in Long Beach ordered by the court for survey to determine whether or not it was trespassing, a trick tubing catcher arrangement with one catcher inverted had been set in the hole to prevent the running of survey instruments. Since no information as to what the obstruction was like was available, attempts at fishing were unsuccessful. A camera was then devised and photographs taken at the "fish" by means of which fishing operations could be commenced. From photographs taken at various stages during the operation the job was successfully completed.

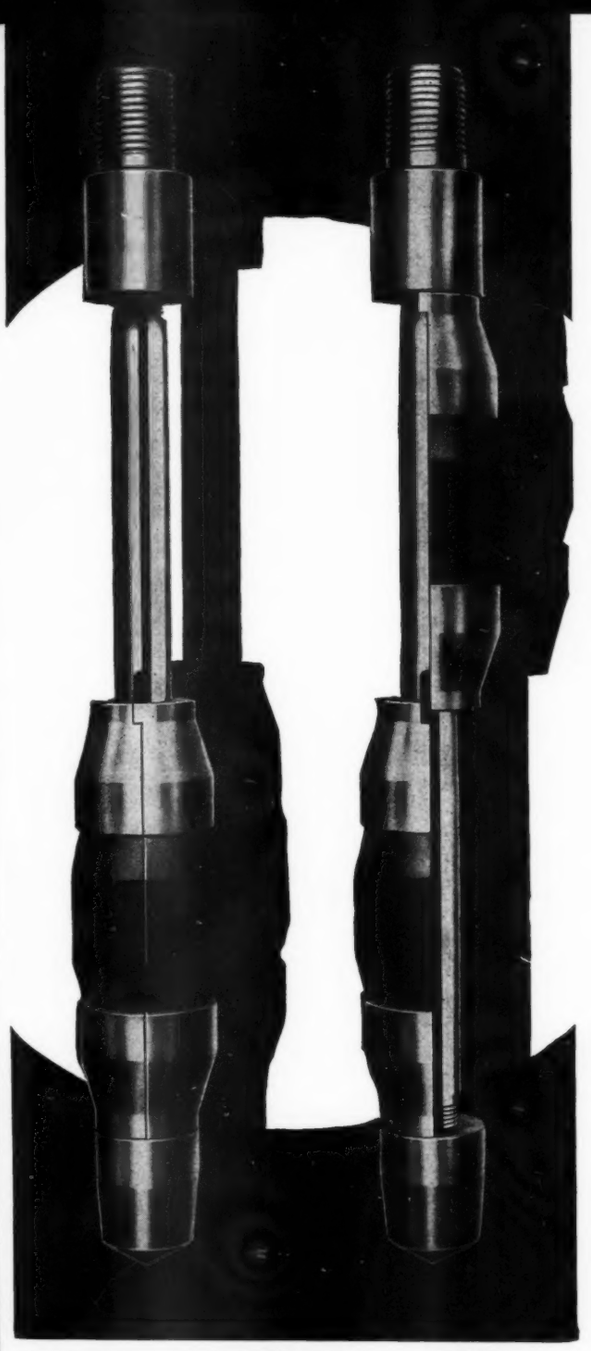
PRODUCTION

Although less than five percent of the total number of oil wells in California are flowing, nearly 30 percent of the state's production is from these wells. A considerable number are deep holes taking oil from high-pressure formations. In the Temblor and Wagon Wheel zones at North Belridge, with wells ranging in depth from 5300 ft. to 5500 ft. and from 8000 ft. to 8500 ft., respectively, in the Hay-Carman area and the Tupman areas at Elk Hills with wells ranging in depth from 2900 ft. to 3500 ft., and in the Kettleman Hills north and middle domes with wells ranging in depth from 7000 ft. to 8000 ft., the natural gas reserves exceed the oil reserves in volume.

High-test fittings are necessary for

Comparative strata logging. On the right is shown a "stratagraph" record of formations taken after the 8⅝-in. casing had been run. The electrical log of the well made in open hole and the log obtained from mechanical cores taken during drilling are shown on the left for comparison





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HUMBLE ROAD - - - - - - - - - - - HOUSTON

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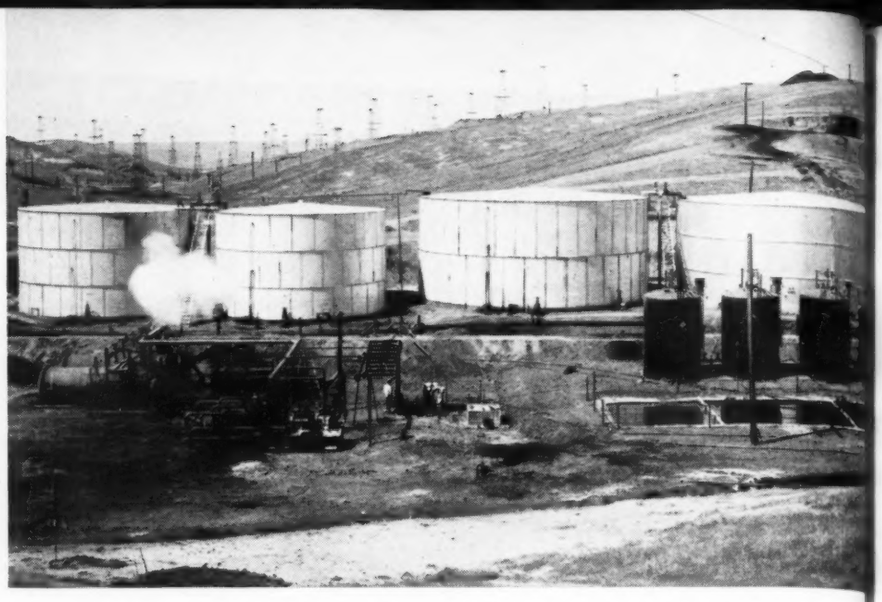


Automatic features recently were installed in this central electrical dehydration plant in the Poso area to modernize the equipment and operation

the high-pressure wells and usually are supplied with ratings of 5000 or 6000 lb. per sq. inch. The Christmas trees now used are simpler than the earlier ones developed in the state, as can be seen in accompanying illustrations. The present trend is toward setting the entire hook-up below the derrick floor where conditions warrant such procedure. When the wells have been drilled by pressure-drilling methods the cellars usually are adequate for such connections. This practice probably started at Kettleman Hills and Ventura Avenue where hillside locations made it economical as well as more effective. In many instances, no matter what drilling technique is employed, the cellars are designed to accommodate flow connections below the derrick floor wherever possible.

Many deep flowing wells will some day have to go on the pump, so it is natural that due consideration be given to any equipment that will aid in economical and efficient pumping methods. Deep pumping with rods has been in progress in several fields, such as Santa Fe Springs where the Clark-Hathaway zone is so produced from depths ranging from 7000 ft. to 8000 ft. Rodless pumps, however, have been given considerable study and the installations made in various parts of the state have provided some valuable data on their performance.

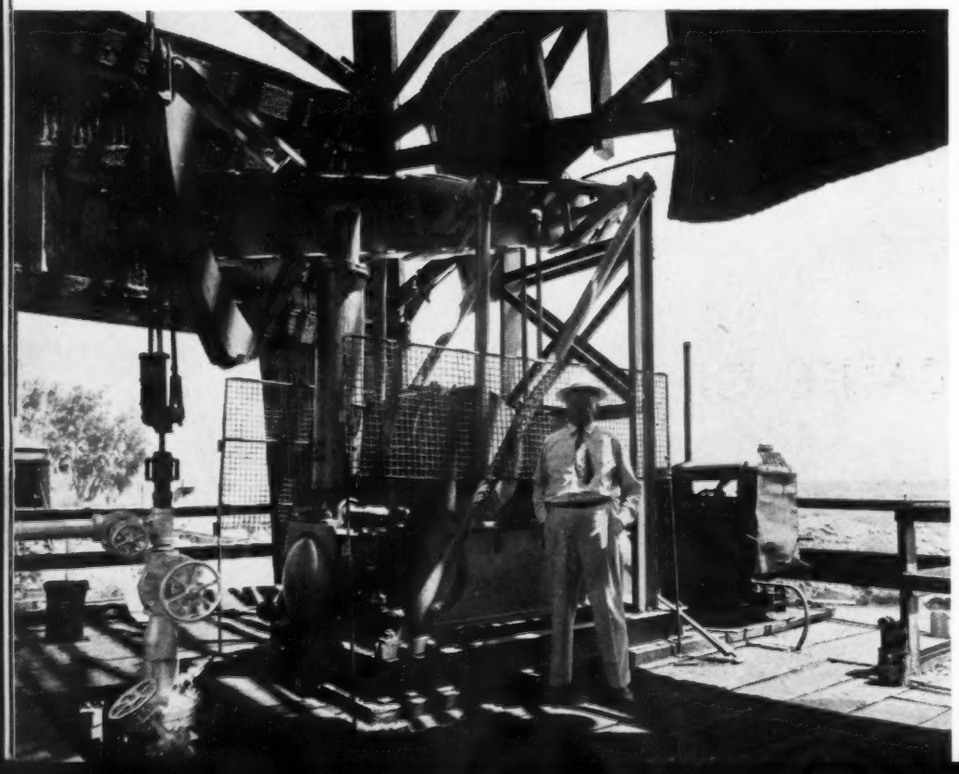
The latest installation is a 4-in. hydraulic pump at Kettleman Hills that is the first of this size to be put into service. This pump has a rated capacity of 800 bbl. per day and has been pumping an average of about 600 barrels. The production is very gaseous and a pressure of 400 lb. per sq. in. is maintained on the casing. Two similar pumps also have been built and will be installed shortly in the Mid-Continent.

Two other wells at Kettleman are being produced with the plunger-lift type pump. Conditions there probably are favorable to its operation, since it utilizes the gas being produced with the oil to supply its energy. The equipment consists of a string of special smooth-bore tubing in which an all-metal plunger travels the entire distance from the top to the bottom; however, the plunger does not lift a column of oil extending the full length of the tubing, but is designed to produce the fluid in short heads of about 300 ft. at a stroke.

Counterbalancing has been an important factor in pumping with rods. The latest design of pumping unit installed in California provides an air-balance that cushions the stroke with air. In operation, compressed air exerts a constant pushing or lifting force against the beam to counterbalance the load in the hole. An air reservoir is under the gear box and air is allowed to flow through the piston stem directly into the cylinder under the beam by opening a valve. The area of the cylinder head is such that it directs against the beam at the point of contact with it a lifting force of 78 lb. for each lb. of air in the system. An adjustable air compressor operates synchronously with the beam and maintains in the air system any desired pressure. A change in speed can be made without changing the counterbalance and a change in counterbalance can be made with the unit in operation.

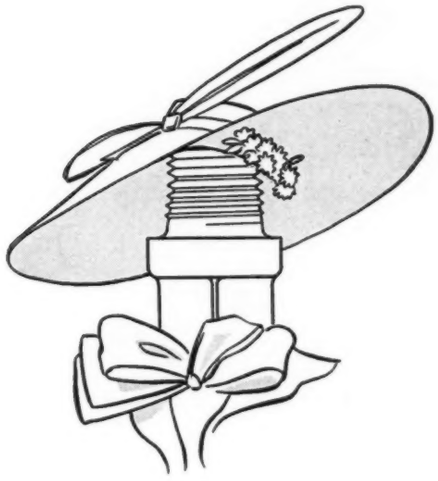
The deepest well yet pumped by this air-balanced unit is one of 7000 ft. depth, producing about 360 bbl. of fluid per day, of which 40 percent is water. A 56-in. stroke is being employed at a speed of 25 strokes per minute. In a 3300-ft. well, 1200 bbl. of fluid per day, consisting mostly of water, is being pumped with a 52-in. stroke at a speed of 37 strokes per minute.

Deep-well pumping now being necessary in many fields every means is taken to reduce as much as possible the pulling and running of tubing. A considerable part of tubing trouble is felt to be caused by the vertical movement of the pipe and its whipping while the well is being pumped. This has led to an increased use of tubing catchers with a mechanically operated anchor that is run on the string and set at a predetermined point above the perforations. It is further believed that



An air-balance Lacy pumping unit installation of the Allied Petroleum Corp. at Mountain View. J. B. De Maria, president of Allied Petroleum Corp., is shown during an inspection trip.

THE SMART SUCKER ROD MOTIF OF THE MONTH



A H--l of a caption for any sucker rod manufacturer to put on his advertisement! That's what you are thinking, and we don't blame you.

Axelson, however, believes in consistency. If our salesmen are going to talk it, why shouldn't we advertise it?

Seriously, though, we have lost faith in any policy of monthly sucker rod motif! We seriously believe that with very few exceptions all oilwells using pumps and sucker rods fall into three general classifications. By this same token we are inclined to question the advisability of making more than one sucker rod to meet each specific pumping condition, as reflected in three classifications.

Engineers of sucker rod manufacturers and oil companies alike have labored during past years toward uniformity of thread, uniformity of upset, length and size in all sucker rods. Truly constructive work has been done in mechanical standardization, beneficial to both buyer and seller.

In the same manner Axelson believes that standardization can profitably be carried on in the material characteristics of sucker rods. Today sucker rod manufacturers adhere strictly to *mechanical standardization*, but seem to be going far afield in any attempt at constructive *material properties standardization*.

Axelson feels that this situation is unhealthy for all branches of the oil industry. It is one on which someone must make a stand — that is just what Axelson is doing. Backed by an experience of forty-four years in the manufacture of pumps and sucker rods, Axelson's analysis of sucker rod manufacture and use indicates a rod for each of the three general classes into which pumping may be grouped.

We recommend for the Industry's consideration a policy of sucker rod materials standardization as reflected in these specific types:

●

A First Rod *of high quality, moderately priced for use in light and reasonably heavy pumping operations.*

A Second Rod *of excellent quality, with high tensile, high ductile characteristics which meets reasonably-heavy, heavy and extra-heavy pumping conditions.*

A Third Rod *combining the best features of the Second, but with the added advantage of meeting conditions in wells where corrosion constitutes a problem.*

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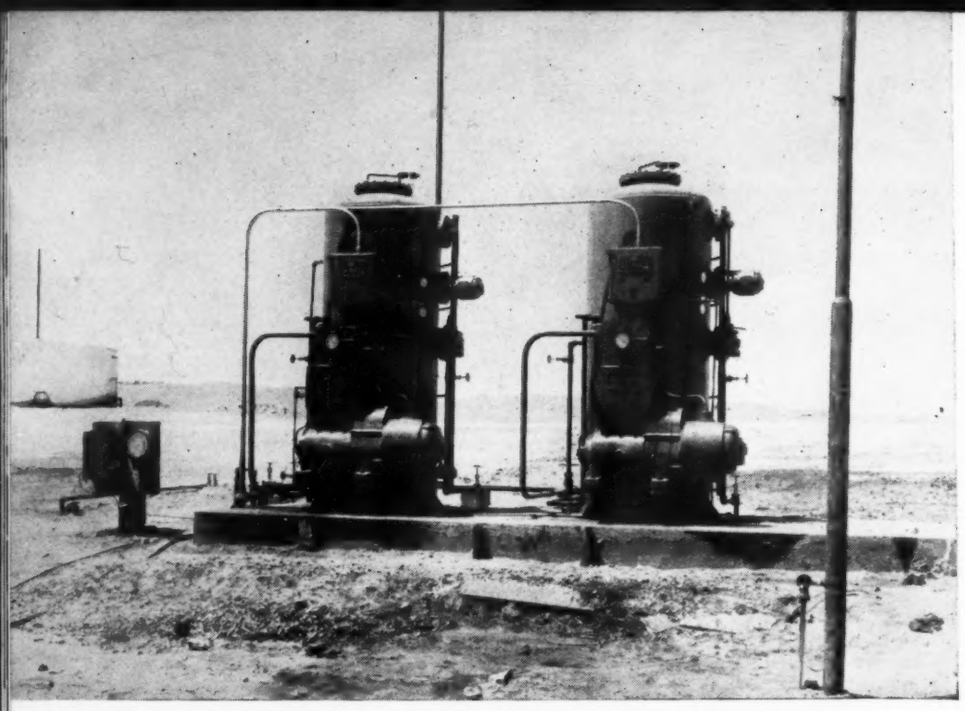
OIL WELL PUMPS **AXELSON** SUCKER RODS



The surface unit equipment for a single large deep-well installation of the new 4-in. Kobe hydraulic pump

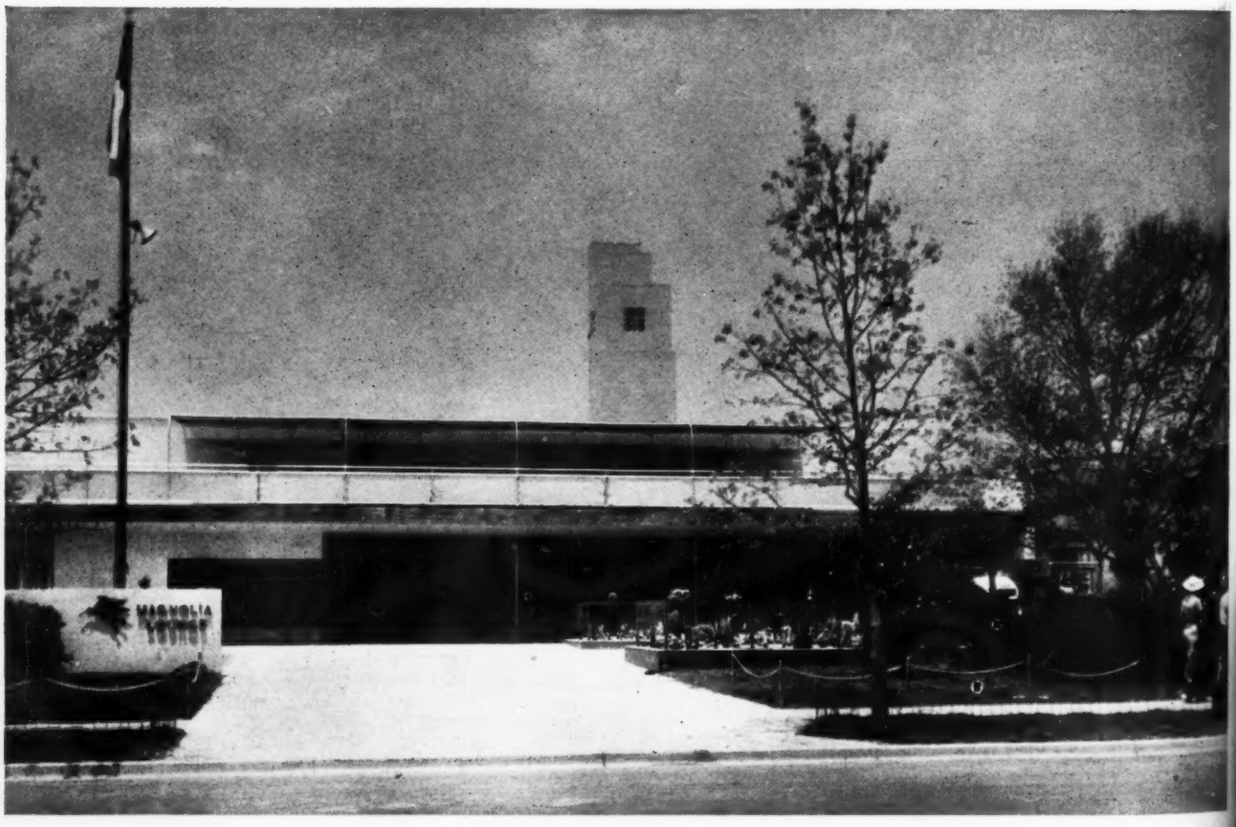
increased production can be obtained by anchoring the tubing, since the length of stroke is not reduced by the movement of the pipe.

The servicing of wells long has been done by means of portable hoists. These have been mounted on trucks, tractors or trailers; a new type has just been introduced that is self-propelled. The object of this design is to save on equipment expense for work where such a type is applicable.

The automatic electroflow method of electric dehydration introduced a couple of years ago for treating the production of a single well, or a group of wells that could be manifolded, not being applicable to a central dehydrating plant, has begun a trend toward the modernization of such central plants to incorporate the new developments and improvements. The principal advantage of the changes made during the past few months has been derived from the installation of automatic features, although there also have been changes made in the electrical design. Among the automatic controls of particular importance are those of temperature, water level, and pump output. The aims of the new designs are increased efficiency and lower operating costs.

Subsurface maintenance and repair work of all types is being given considerable attention. The use of cement for repairing wells probably has been increased by the improvement of equipment for its placement. The new hydraulic-type cement retainer has been introduced and has facilitated the placing of cement behind liners and casing either under pressure or, in contrast, in zones requiring the elimination of even the hydrostatic pressure in the hole after the cement has been placed. Several cementing jobs in California requiring pressures greater than 3000 lb. per sq. in. have been performed with this tool, which is especially advantageous where re-cementing or squeeze jobs have to be done without circulation.

Magnolia Lounge at Texas Centennial Exposition



Are These Your PUMPING TROUBLES in Oklahoma City?

Fluid Packed Pumps Whip Pumping Problems in Oklahoma City Field!

Excessive breaking of combination strings made up of 7/8-inch and 3/4-inch sucker rods are attributed by many Oklahoma City operators to sand or mud retarding the drop of the pump plunger. The 3/4-inch rods, put in compression by the weight of the heavier 7/8-inch rods above them, are subjected to abnormal bending stresses which soon result in a rod break near the middle of the 3/4-inch string. Rod failure is not the only trouble resulting from this condition; tubing wear and strain are also caused by buckling of the rods and transfer of load.

Right here is where Fluid Packed Pumps play their important part in combating such rod and pump troubles. The liberal annular clearance (20/1000") between the loose-fitting telescoping tubes is large enough to carry sand grains without freezing, reduce friction, and permit the pump plunger to drop freely. Rod failures are thus minimized and time, trouble and expensive repairs to rods, tubing and pumps are saved.

Keep your well clean of sand and mud and it will remain on steady production — yield the greatest amount of oil at the lowest cost per barrel. Wherever sand or mud are contributing factors to pumping troubles, put a Fluid Packed Pump on the job. Call our nearest office for a service engineer, or write for illustrated bulletins describing the operation of Fluid Packed Pumps.

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A MODERN PUMP FOR MODERN CONDITIONS

Protected by Patents No. 1545474, 1545475, 1549175, 1621046; others pending.

Progress in Well-Acidizing Practice

By LEO H. TOWERS

New products and methods aid in controlling placement and action of acid in wells

SEVERAL new methods, successfully attempted, in the treatment of oil wells with acid during the past year show the variety of problems that can be solved by this means. Not only have new uses for acidizing been found, but the materials and technique in the more conventional treatments definitely have been improved. For a phase of oil field practice so young much progress has been attained in research and application.

Briefly stated, the history* of acidizing covers a period of only four years insofar as modern commercial treatment of oil wells is concerned. Its original purpose was to increase production in old stripper wells in fields where wells were rapidly being plugged because they could no longer be pumped economically. Thousands of such wells have since been treated, with the result that ultimate recovery has been increased or the rate of recovery increased, and thereby the per-barrel lifting cost reduced. Success in old wells led to its gradual use in new wells as they were completed. Application of acidizing to new wells was delayed somewhat because of overproduction and proration in new fields. Despite this, however, there has been an increasing use of acid in new wells until during the past year it is estimated that an equal number of old and new wells have been acidized.

Due to proration it is often impossible to get a true production decline curve that will show the result of acid treatment; however, from the decline curves of older wells and the apparent increase in production following acidizing, it seems safe to say that an increased rate of production will result during the life of the well. Table I shows the increase in production following the treatment of typical lime wells in Kansas. Production is increased from 86 percent to 630 percent due to the first treatment, and the second treatment shows increases from 168 percent to 462 percent, compared with initial production. As a means of following the progress of wells where production is fixed by proration, a pressure decline curve might be the solution. Among other information that could be revealed by such records would be the proper time for acidizing and reacidizing.

The acidizing of new wells also is being employed for the purpose of controlling reservoir energy, gas-oil ratio, oil-water ratio, and increasing the capacity of input wells used in salt water disposal and water-flooding operations. It also is interesting to note that during the past year sulphur wells in Louisiana have been acidized. Conserving reservoir energy is a problem of importance to the oil industry today and since acidizing has found application in proper pressure control its relation to this problem is significant. An acid treatment will lower the resistance to flow, decrease the pressure drop and permit a higher subsurface flowing pressure, as well as a slower decline in formation pressure. The pressure differential is determined by the resistance to flow offered by the formation and by the rate of flow through that formation. Under proration the flow necessarily must remain constant and consequently the pressure drop is determined by the resistance to flow or permeability of the formation.

In New Mexico allowables are determined by the number of producing wells in an area, rather than by the potential production of individual wells. In acidizing in this area the aim is to obtain better utilization of reservoir energy and to keep the gas-oil

*"Acid Treatment of Oil Wells," by K. C. Sclater, *The Petroleum Engineer*, April, 1933.

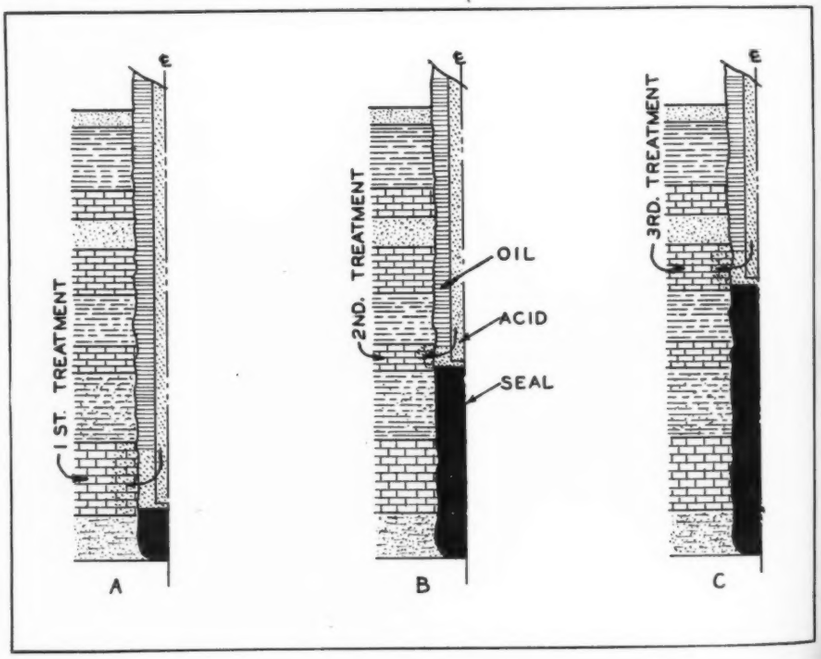
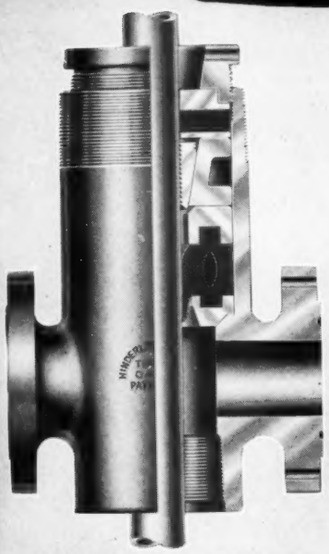


Fig. 1. Method of applying separate acid treatments to two or more producing horizons in a well by means of a seal

BY HINDERLITER

SLIP TYPE CASING HEAD EQUIPMENT

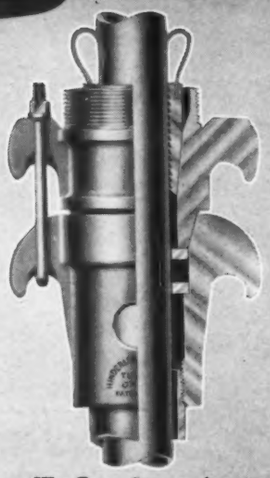


Type HZW—Three-in-One Casing Head Hook Up with flanged outlets and auxiliary packing mechanism.

Designed, to hold and suspend, lower and pull long strings of well casing and tubing,—to provide a sealing or packing means at the top of the well—to set well packers and underream without the loss of pressure or fluid—to lower and run well tubing and casing under pressure and to core and drill in wells by the rotary pressure method.

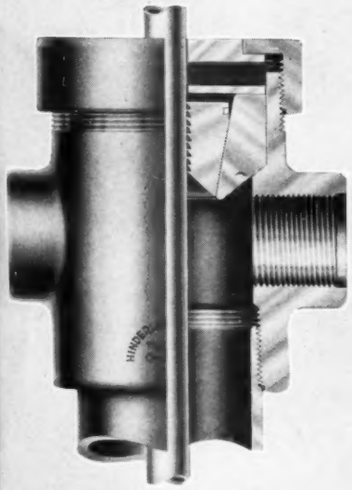
Greater versatility and interchangeability of Hinderliter heads permits the making-up of the proper combination for any drilling, flowing, and pumping situation.

When a Hinderliter installation is made on a well, no special fittings, equipment, or operators are necessary to run the tubing. All units can be used in combination or connection with standard fittings and devices. Contain safety factors not found elsewhere.

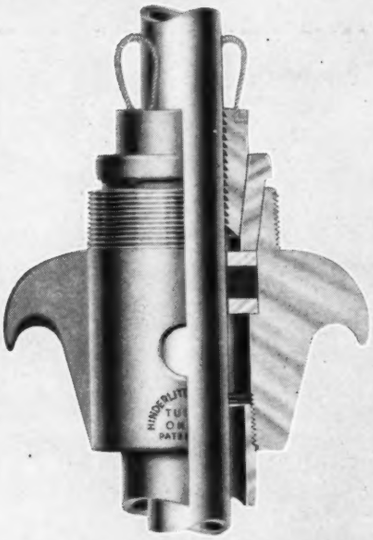


Type HL—Two piece casing support and packing head, threaded top and ear lugs for tie down equipment and elevator links.

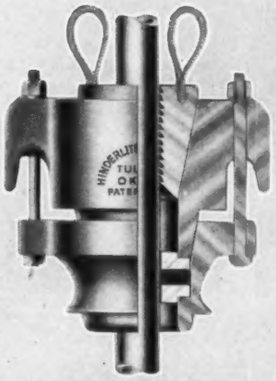
SOLD BY SUPPLY STORES



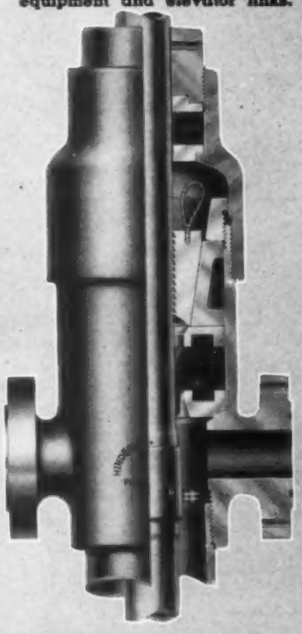
Type HW—Two-in-One Casing Head Hook-Up with wedges.



Type HJ—Bushing type casing support and packing head with lifting ears.



Type HM—Mildren Tubing Support used on pumping wells and can be used in any casing head.



Type HZ—Three-in-One Casing Head Hook-Up with top packing gland and flanged outlets.

When your problems become so difficult that outside suggestions are necessary consult—

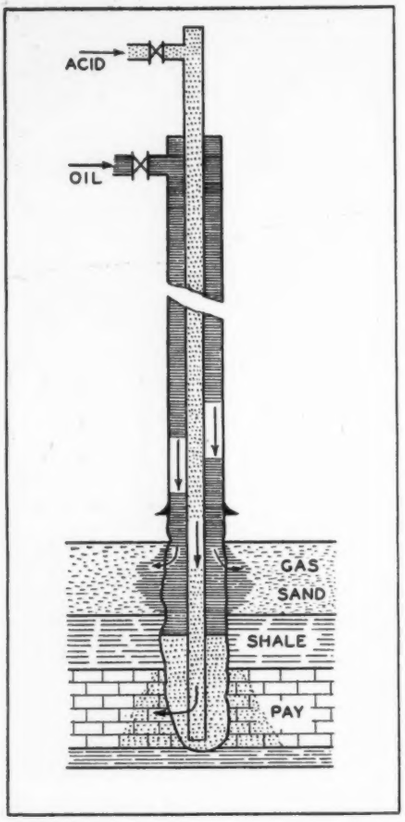


Fig. 2. "Two-pump" method of treating a well with acid

ratio below the 3000 cu. ft. maximum required by the state.

By acidizing the oil zone without bothering the gas zone, an increase in oil production may be obtained that results in lowering the gas-oil ratio. By acidizing the gas zone an increase in gas-oil ratio may be obtained and also an increase in available energy that results apparently in a more economical rate of production. Definite knowledge of the producing formations is necessary to accomplish this.

In areas where excessive water comes into the well and where the source of the water is known to be from certain sections other than the oil sand, it is possible to acidize only the oil zone, the water zone being protected by a "blanket" solution.

Recently input wells for the disposal of salt water have been increased in capacity by acid treatment. In Michigan a salt water well into which had been pumped 30 bbl. of water an hour under a pressure of 300 lb. at the surface was found, following treatment with acid, to take at least 100 bbl. per hour at no pressure. Unfortunately no figures are available concerning the long-time effect of this treatment, as owing to other circumstances, the well soon was abandoned as a water disposal well. The same sort of treatment is used on water input wells for flooding operations where the formation flooded contains limestone. Even in water-flooding operations in sandstone reservoirs acid has been used to dissolve precipitates obstructing the flow of the water at the face of the well.

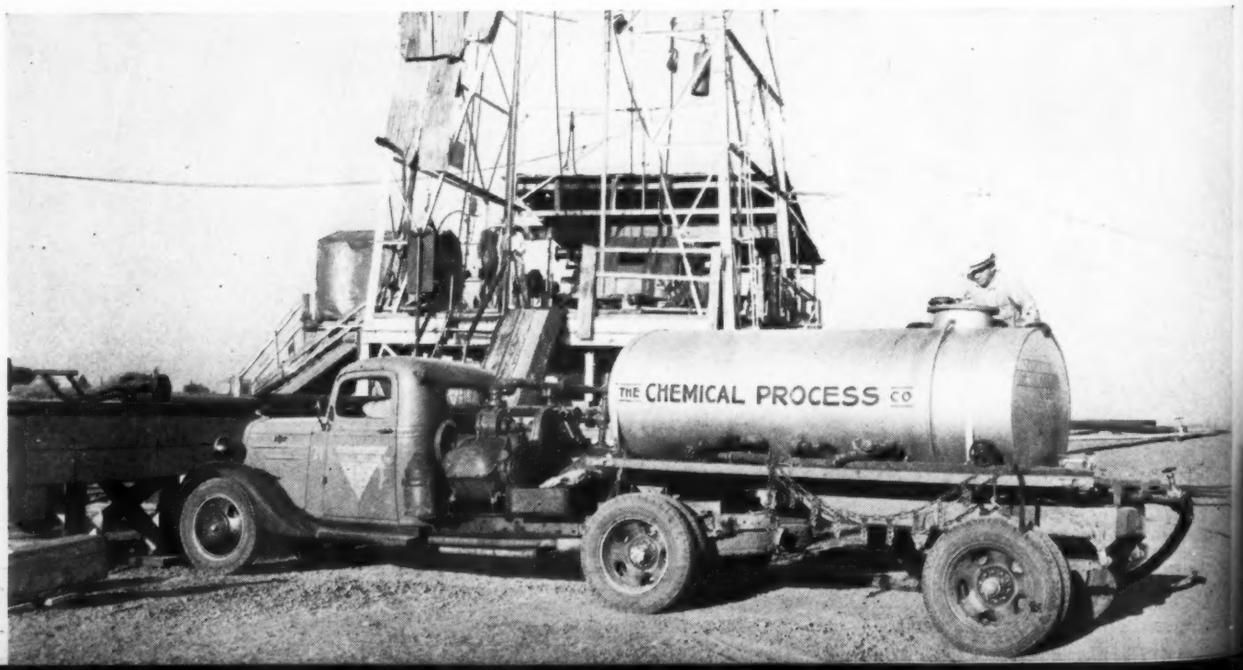
The last year has seen the adoption of acid that has a low surface tension. This acid, while recommended particularly for tight formations and old stripper wells where little or no reservoir pressure remains, can be used for any acidizing job. Its advantages over the regular acid is its ability to penetrate more area before it becomes neutralized and makes possible more complete withdrawal of spent acid solutions.

An important advance in controlling the placement of acid has been made in recent months by the use of a jelling solution. This is an organic material that gelatinates in the sand in the well and is a laboratory development. It is utilized for temporarily plugging off porous sands below the point where acid treatment is desired. Tests have proven that under pressures as high as 700 lb. this jelling solution will penetrate the sand no more than an inch. To assure that permanent plugging of the lower sands is not caused by this jelly seal, a bacteria culture of sufficient quantity is added to each batch of seal to consume the organic matter in from 24 to 36 hours, allowing the digested jelly seal to come out with the oil.

In the Fitts Pool, one of Oklahoma's most active fields, jellying solution is employed successfully because of the many separate and distinct formations from which oil is produced. In the past the method of treating each pay to be sure that it received the proper amount of acid was to shut down and acidize immediately the drill had passed through one of these formations. Under this procedure several expensive shut-downs occurred in the course of drilling one well. When a jelly seal is used the well is completed to its total depth. The seal is then applied to plug back to the lowest formation receiving treatment (see A, Fig. 1), the pay acidized; jelly solution again added up to the bottom of the next lowest pay formation (see B, Fig. 1), and so on until all formations have been treated (see C, Fig. 1).

In other areas, porous gas sands above the oil formation were found to be taking the acid intended for the oil pay. To correct this a high-pressure pump may be connected to the

Chemical Process Company, Inc., solved a stuck drill pipe job for S. S. Young, Ponca City, Oklahoma, drilling contractor, who had 6000 ft. of pipe stuck 80 ft. off bottom in Pure Oil Company's No. 9 Malm well at Edmond, Oklahoma. One thousand gal. of chemicals did the job, in lime formation. *(Photo courtesy Wallace Davis, Advertising, Houston, Texas)*



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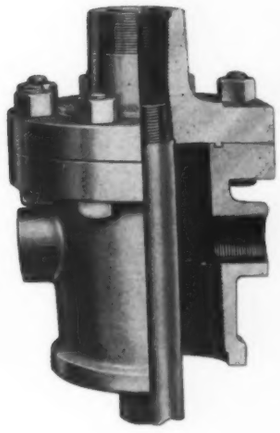
BAASH-ROSS
PRODUCTION TOOLS

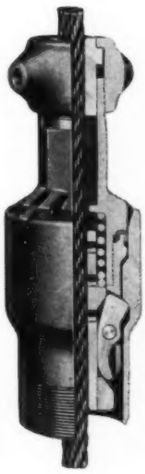


OPEN END TUBING SPIDER

The quick acting end gate makes this sturdy spider a real promoter of speed and safety in handling tubing. With the end gate removed, the spider is quickly placed around the tubing without disturbing any connections. To prevent the spider from spreading under even the heaviest tubing load, the end gate is dovetailed and securely held in place by a large alloy steel bolt. The spider may be rested on or bolted to the tubing head, or placed directly on the derrick floor. The wide top flange provides a resting place for the slip assembly between applications.

A firm, non-slipping, non-swaging grip on the tubing is assured by the four accurately cut slip segments. All slip segments are attached to the hinged tong and cannot come loose. Slips are latched around the pipe until removed by turning the grip of the tong handle.

See the complete 52-page Baash-Ross section in your 1936 Composite Catalog. It begins on Page 115.



TYPE "C" TUBING HEAD

Here is a tubing head that combines unusual economy with maximum safety. While designed for use on wells of comparatively low pressure, it is so strongly built that it has a safe working pressure of 1000 pounds. The tubing is screwed directly into the lower internal thread in the flange, the upper internal thread being used for other connections. A gate valve or christmas tree may be screwed on the external flange thread. Made in all sizes.

AUTOMATIC RELEASE OIL SAVER

Indispensable when swabbing or bailing. Saves oil, keeps the derrick floor clean and safe. Body screws into the gate valve and the plug fits around the wire line. Scientifically designed packing prevents escape of fluid around line or body joint. Full bronze bushings prevent wire line from contacting steel, eliminate hazard of sparking. Plug instantly releases and lifts out of body on the line when rope socket contacts bottom of plug. When the swab or bailer is started down the hole again the plug enters the body and automatically latches in place.

BAASH-ROSS TOOL COMPANY

BAASH-ROSS

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casinghead and a constant stream of oil forced down the casing at the same time that acid is slowly pumped down the tubing at sufficient pressure to force it into the oil horizon (Fig. 2). This is called the "two-pump" method of treatment and is a definite contribution to acidizing technique.

Shorter shut-down time is now advocated in acidizing. Modern methods require that the acid be removed from the well before it is entirely neutralized. There are two reasons for this. By reversing the flow through the formation while the solution is still slightly acid, it will have a chance to work both ways through the cavities and channels and increase the possibility of enlarging them by working on both sides of any protruding obstruction. The second reason for removing the acid while it is still active is that it may carry out with it particles of loosened clay, paraffin, and any other materials that otherwise might settle out or precipitate and remain as accumulations that would prove deterimental to oil production.

An average treatment today is almost double that of a year ago. Twelve months ago the average treatment was 1500 gal., while now the average exceeds 2500 gallons. This increase is due chiefly to increased acidizing of new wells. Whereas 1000 gal. is considered an average treatment for stripper wells, new wells take from 3000 to 10,000 gallons. Recently a well in southern Oklahoma was treated with 10,000 gal. and two weeks later received a second treatment of 15,000 gal. for a total of 25,000 gallons. This is believed to be the largest acid treatment yet made.

TYPICAL RESULTS OBTAINED BY ACIDIZING NEW WELLS IN KANSAS

Field	Formation	Initial Prod. (Bbl./hr.)	Acid (Gal.)	Prod. After Acid	Increase in Prod.	Reacid. (Gal.)	Prod. After Acid	Increase (Over I. P.)	Time Between Treatments
Oxford.....	Arbuckle.....	85	3000	250	194%	8000	478	462%	1 day
Oxford.....	Arbuckle.....	10.6	3000	29.6	179%	8000	41.6	292%	2 days
Turon.....	Trenton.....	25	1000	182	630%				
Bueler.....	Hunton.....	2.8	4000	5.2	86%	3000	7.5	168%	7 days

Where once only strictly lime formations were acidized, now only strictly sand formations are not. In other words, almost all producing formations composed of limestone, dolomite, or sand lime may be acidized with good results. Practically all oil-producing states have had some wells acidized. The one exception that might be listed is California and even there one of the larger acidizing companies recently has established treating facilities.

In Michigan, where acidizing has been used extensively in the past, there is more acidizing being done now than ever before. Most Rocky Mountain production from Montana to New Mexico is obtained from limestone formations. Active areas in Kansas, Oklahoma, West Texas, Arkansas, Louisiana, Illinois, and Kentucky also are the scenes of successful acidizing programs. Several producing fields where the productive strata are wholly sandstone, notably in the East Texas and Gulf Coast areas, still resist treatment by acid.

Modern surface equipment used in acidizing. It consists of a 4-ton truck on which is mounted a 3¾ by 5-in., 2800-lb. pressure, horizontal triplex pump and a 1000-gal. acid tank. Another 1000-gal. tank is mounted on a trailer. Each tank is equipped with an automatic syphor

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The District Court of the United States for the Southern District of California, Northern Division, has just handed down its opinion that Johnston Formation and Casing Testers DO NOT INFRINGE United States Patent No. 1930987, owned by Erle P. Halliburton and Halliburton Oil Well Cementing Company.

Operators everywhere made the decision to continue to use the Testing Tool which, in their opinion, produced the results they required. Consequently they have favored us with their business. We take this opportunity to express to them our sincere appreciation of their support and cooperation, and to pledge even better service and results for the future.

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★ **THE TRIP VALVE,** an exclusive feature fully covered by patents, assures the operator that any fluid contained in the drill pipe after a test has been made is an accurate sample of the contents of the formation tested.

It also differentiates between a test and a drill pipe leak.

"ACCURACY IS PARAMOUNT"

★ **THE EQUALIZING VALVE,** another exclusive feature fully patented, eliminates the dangerous pull which would otherwise be present when lifting the packer from its seat.

It equalizes the unbalanced pressures above and below the packer before lifting it.

"SAFETY COMES FIRST"

★ **ACCURATE DEPTH PRESSURE RECORDERS,** are run as a regular part of the Johnston Formation Testing Service.

All recorders are checked regularly in our modern Calibrating Laboratory.

"A GAUGE IS NO BETTER THAN ITS CALIBRATION"

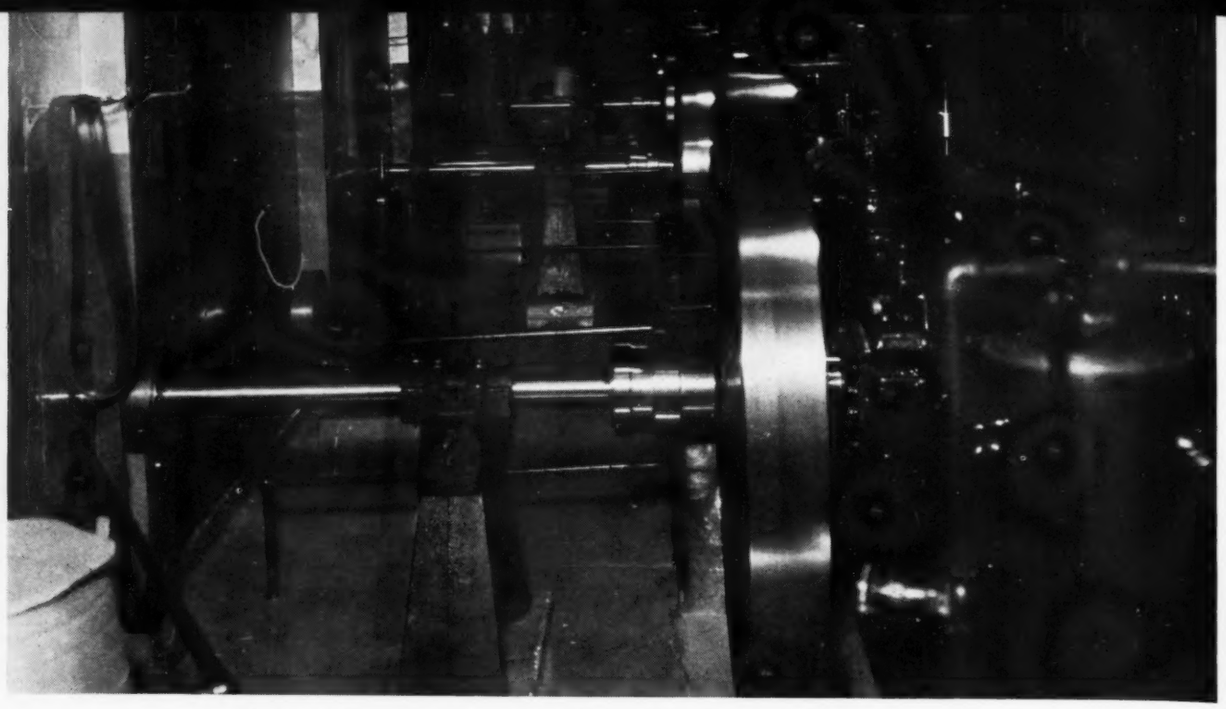
★ **SERVICE.** The Johnston Formation Tester is serviced and handled by experienced well men who know Formation Testing.

"WE'RE THERE WHEN WE'RE NEEDED"

★ **FULL PROTECTION.** The Johnston Formation Tester is covered by the following U. S. Letters Patents:

1,709,940 — 1,842,270
1,715,504 — 1,901,813
1,790,424 — Other Patents Pending.

BEFORE YOU KNOW?



Interior of Lucas Station of Gulf Pipe Line Company, Beaumont, Texas

Progress in Pipe Line Construction

By FRANK H. LOVE

The past year has seen improvements in existing types of equipment, as well as new developments in construction and maintenance methods

ALTHOUGH there have been no advancements in the pipe line industry within recent months that could be considered of a revolutionary nature, steady progress has been made in the application of earlier developments, and in the improvement of existing types of equipment. Lighter weight, more compact pumping units continue to gain in favor wherever conditions justify their use. In instances where Diesel engines are employed as prime movers the trend is toward light-weight and higher-speed units. Progress constantly is being made in the matter of protecting pipe lines from corrosion. Methods of analyzing corrosive conditions in soils have improved materially, experiments are being made continually with a view to improving pipe coatings and wrappings, and advancement is noted in the matter of cathodic protection. Forward strides in pipe line welding technique and equipment have resulted in certain economies in line construction. The more widespread practice of designing and using pipe to meet certain operating conditions, particularly the use of thin-walled pipe in gathering and low-pressure systems, is of outstanding importance. Of significance, too, is the acceptance of gasoline pipe lines as an economical method of transportation, as is evidenced by the recent construction of new lines for this purpose.

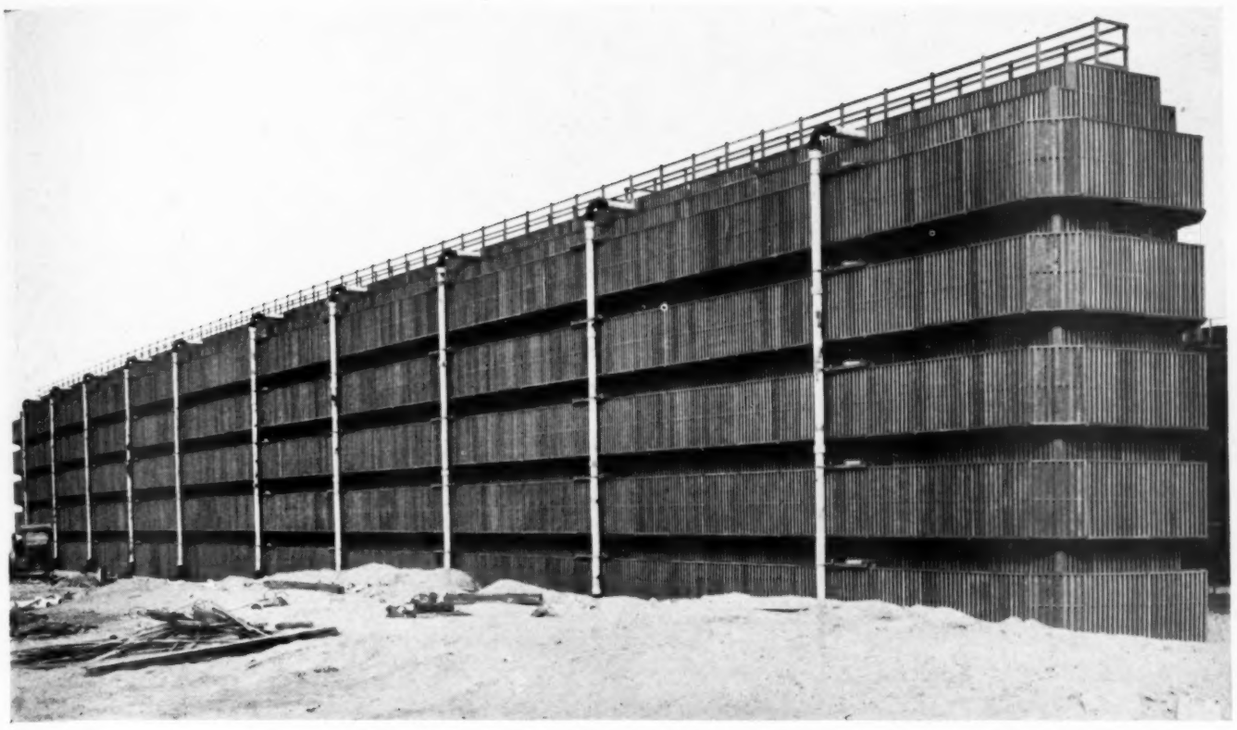
Line Construction

Pipe line construction practices and equipment have become fairly well standardized; however, periodically a departure is made, necessitated either by circumstances or a desire on the part of the operator to experiment with what may prove to be a valuable addition to accepted technique. When the Valley Pipe Line Company, for example, laid a 5½-in. line from the Sam Fordyce field of Hidalgo County, Texas, to Port Isabel, a distance of 88 miles, it was decided to use Dresser couplings throughout at pipe joints,[1] except that welding was resorted to at all bends and sags, marking the first time couplings have been employed so extensively in the construction of an oil line, although their successful use in gas transmission systems covers a period of many years. The couplings in this instance served a dual purpose, acting as expansion joints, as well as pipe couplings.

An interesting construction job completed during the early part of 1936 was that of the Continental Oil Company from the new Tepetate field of Coastal Louisiana to a point near Lake Charles, Louisiana.[2] Two lines, one for the transportation of gas, the other for crude oil, were laid in the same ditch. The oil line was constructed of 6⅝-in. diameter pipe and the gas line of 8⅝-in. pipe. Although each line was but 45 miles in length many construction difficulties were encountered, since a considerable portion of the right-of-way was through swampy country. This method of laying two lines in the same trench served to reduce considerably the laying costs.

Quite frequently it is necessary to lay a line under conditions that require the utmost in engineering ingenuity. Water crossings oftentimes present extreme difficulties. Recently an 8-in. line of the United Gas System, extending across Nueces Bay above Corpus Christi, Texas, parted during a storm and its replacement necessitated the devising of special equipment and methods of procedure, illustrating the difficulties sometimes encountered in pipe line construction and maintenance work.[3] When the tide is low Nueces Bay becomes a vast body of black muck, but when the tide is high it is sufficiently deep to be extremely hazardous, especially when a strong wind is blowing in from the Gulf of Mexico.

(Continued on page 112)



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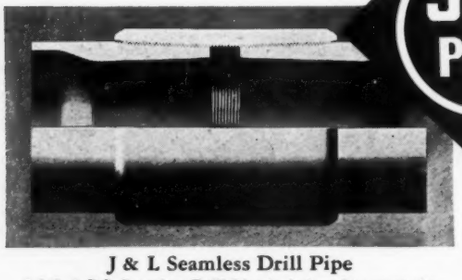
Another reason for the widespread preference for J & L oil country tubular products is the money-saving quick service that J & L provides through the J & L Warehouse at Memphis, and through strategically located J & L distributors.

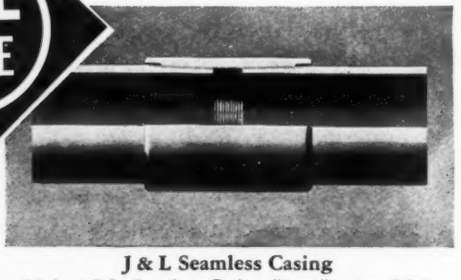
Look to J & L for your requirements—and enjoy the bigger profits that come from better pipe—and the savings that come from quicker service.

J&L PIPE



J & L Seamless Drill Pipe

J & L A.P.I. Seamless Drill Pipe is designed to meet the most exacting requirements and is in use in the deepest zone of production, exceeding 10,000 feet. Integral-Joint Drill Pipe, Jones & Laughlin's latest contribution to the petroleum industry, has a "built-in" tool joint which means fewer failures, and cheaper and more rapid drilling.



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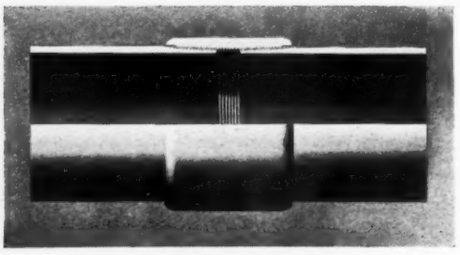
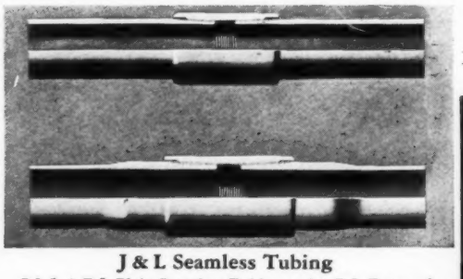
J & L A.P.I. Seamless Casing, like all other J & L Seamless tubular products, offers maximum strength and safety. It is made from a solid billet, pierced, expanded, rolled and finished without any joining of edges. Available in a full range of sizes.



J & L Seamless Line Pipe

J & L Seamless Line Pipe has an enviable record in the exacting service of transporting oil, gas and gasoline. Seamless line pipe is available in a full range of sizes. Can be supplied coated, dipped or wrapped for added protection against corrosion encountered in the field.



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J & L A.P.I. Plain Seamless Tubing and A.P.I. External Upset Seamless Tubing are quality products with exceptional performance capacity. Their rugged strength and durability have been proved again and again under widely varying and extremely difficult conditions. Available in a full range of sizes.

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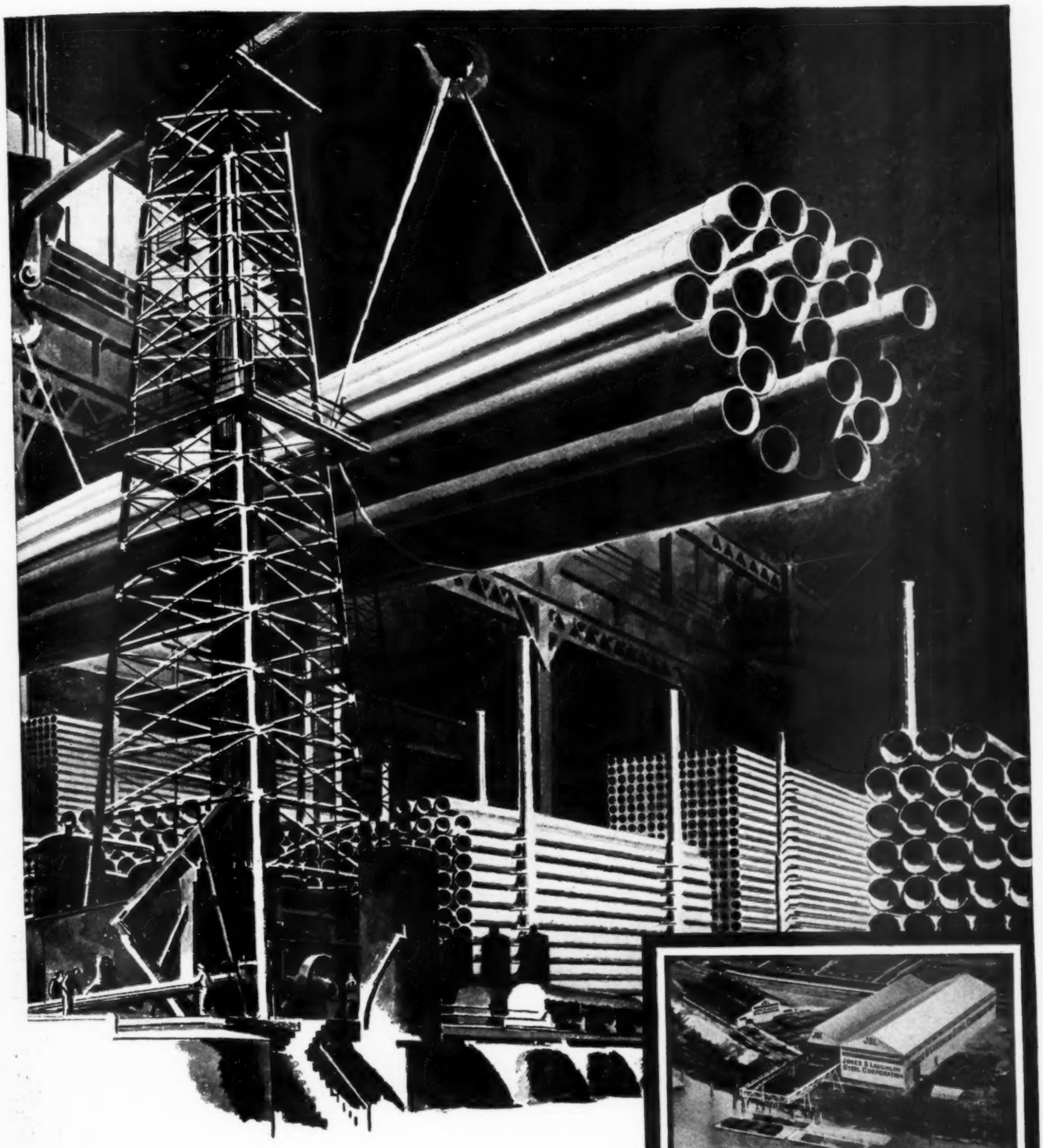
Every Sixth Man Your Man . . .

Every sixth man in the J & L Seamless Tube Department is engaged in the work of inspection—making sure that the product will meet your requirements. Our system of analyzing, checking, verifying is based on your past experience, your present and future needs.



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For the Petroleum Industry include: steel for derricks and other structural purposes; tin plate for containers; seamless steel boiler tubes; tank barges; and bars, shapes, plates, steel piling, concrete reinforcing bars, wire and nails—for maintenance, construction and repairs.

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(Continued from page 108)

When workmen began replacement of the section of pipe the tide and wind had whipped it about until it was in a very badly tangled condition. Following a preliminary examination, in which aerial photographs played an important part, it was decided to salvage the old pipe and re-use it to as great an extent as possible. At no time during the course of the work was the water more than ten inches deep and for the most part there was no water whatsoever, merely a sticky mud. Such conditions required the use of extremely shallow draught barges and heavy pulling and hoisting equipment. A piece of equipment designated as a "mud hen" was devised by engineers on the job. It consisted of a barge having a tractor rear end connected to a gasoline engine. Heavy plates were welded paddle fashion to the axle shafts of the tractor, and these were extended to the outside of the barge hull, the "mud hen" being propelled in this manner through the mud and shallow water. This apparatus served to move the barges containing men and materials about the Bay, and also aided in the handling of pipe.

When actual work began the method of procedure was to recover the pipe by anchoring a tractor equipped with a winch on shore and hooking onto the pipe in the bay, giving it a steady pull until a portion broke loose. The sections thus recovered were buoyed up by pontoon-type barges, and with one end fastened securely to a working barge, floated into position for welding to the line. After each section was tied in it was then anchored until another section could be placed for welding, this procedure being continued until the job was completed.

Station Operation and Design

A variety of types of prime movers continue to be used for the pumping of oil, gasoline, and gas. Diesels, gas and gasoline engines, and electric motors are the power equipment employed, each being used where it will best serve the purpose for which it was designed. In the construction of new field stations the trend of recent years is followed in that high-speed, compact units are used wherever possible. On main lines, too, it has been found that units smaller than once was thought practicable can be utilized. The trend in compressor station equipment also is toward the use of lighter and more compact vertical units. This light-weight equipment is favored because it is more easily installed and repaired, occupies less space, and can be more readily salvaged and moved to a new location when such becomes advisable.

Steady improvement also is being made in connection with pipe line station operation. Close attention to operating details is resulting in longer life and more efficient performance of equipment. Air filters are being used more widely on prime movers; crankcase or engine sump oil is maintained at as nearly uniform temperature as possible; gauging devices whereby distant tanks can be read from the station office are being used somewhat more extensively than formerly; and manifolds are being improved upon, to enumerate a few of the many factors contributing to better operating performance. (See also articles beginning on pages 54, 74, and 83.)

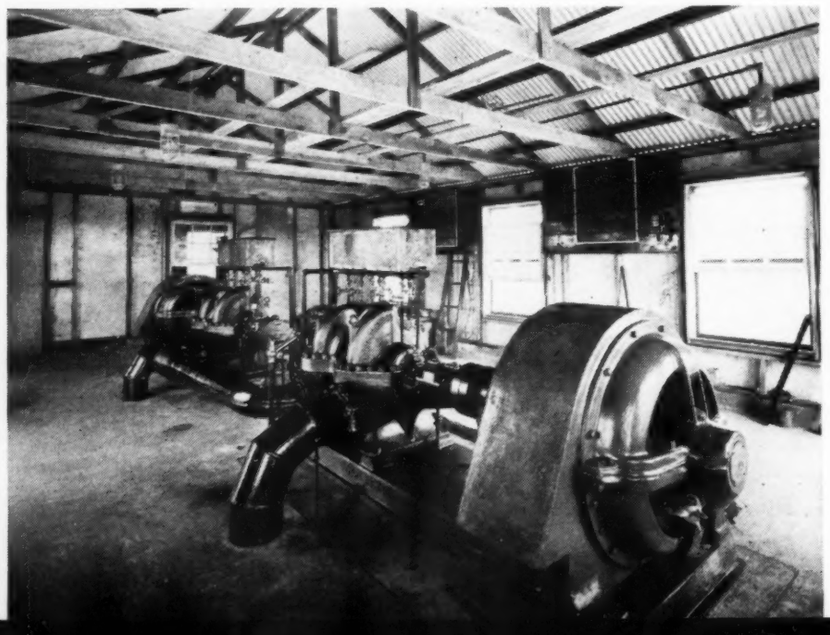
When the East Texas Pipe Line Company laid a line from the Rodessa field of Louisiana to Longview, Texas, in the East Texas field, two stations were erected that created considerable interest among the pipe line fraternity due to the type of equipment used.[4] The latter consisted of centrifugal pumps driven by steam turbines. Although this type equipment was one of the first to be employed in pipe line service, the recent interest was due to the fact that comparatively few stations have been so equipped of late years. Its use in this instance was motivated by the abundant and inexpensive gas available and the plentiful supply of the proper kind of water.

Each station has two steam-driven turbines direct-connected to centrifugal pumps, the turbines being arranged in series. The steam plant consists of three 250-hp. boilers, one being used as a standby.

Pipe Protection

Each year sees new developments in the matter of protecting pipe lines from corrosion and the past year has been no exception. Since corrosion is one of the principal factors in the deterioration of pipe line systems it is but natural that all major companies should carry on a continuous fight against this destructive agent. The results are seen periodically in the development of new coatings and wrappings, new methods of providing cathodic protection, etc. Supplying electric current in areas where purchased power is unavailable at one time was a serious handicap in protecting pipe against electrolysis. This handicap has been overcome in various ways. Wind-powered generators have been improved upon in such a manner as to make possible their more widespread use.[5] Recent developments have consisted of a perfected automatic current regulator, and improvements that enable the unit to begin operation on a lower wind velocity than formerly. Current is maintained at the rated output of the unit regardless of external resistance by means of the automatic regulator, and the lower wind velocity required permits the use of the equipment in areas where otherwise it would operate such a small part of the time as to render it ineffective.

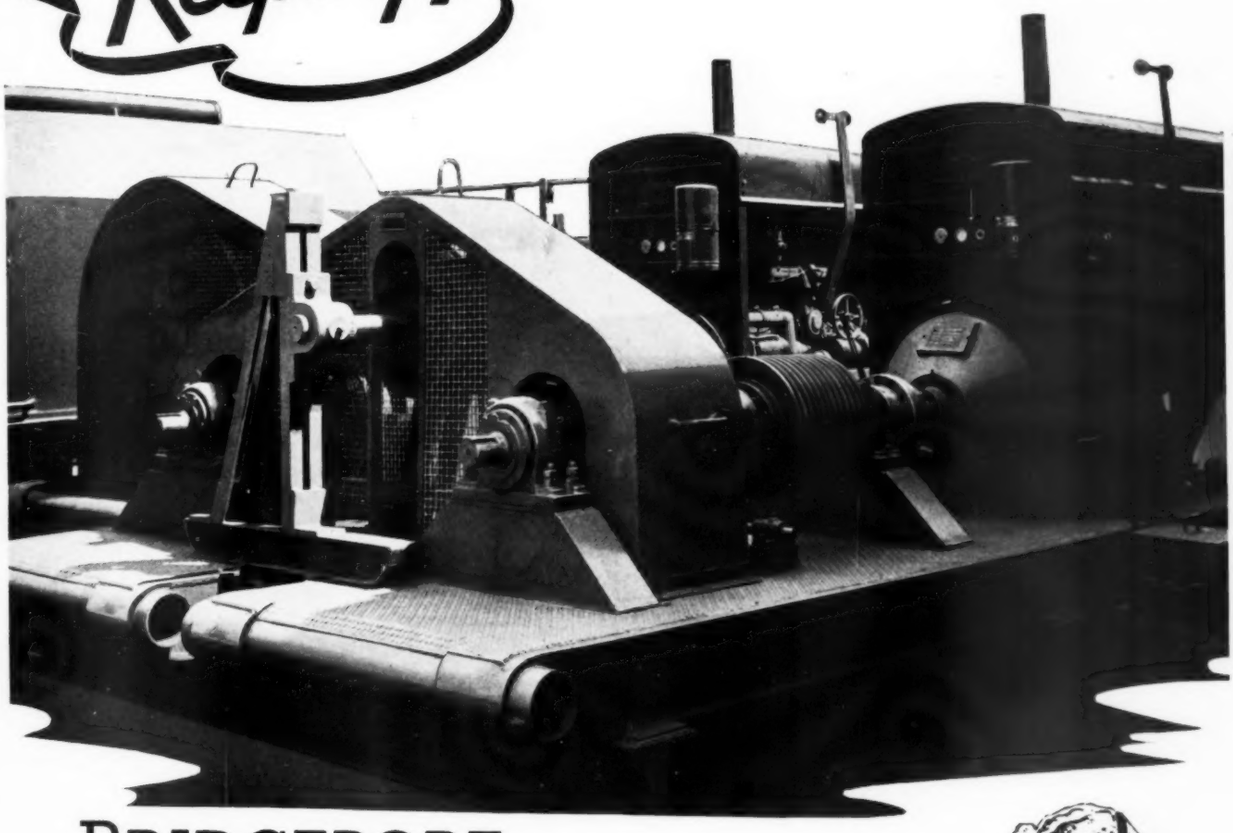
Another method of obtaining current for use in cathodically protecting pipe lines has been devised by the engineering staff of the United Gas Public Service Company at Houston, Texas.[6] Briefly, the method consists of producing electricity by the corrosion of scrap iron. In making the initial installations, casks (hogsheads) were used for the battery cells. Into the bottom of each cask a copper plate was placed and covered with a concentrated solution of copper sulphate. Above the latter was a one percent solution of calcium chloride to which was added ¼ percent acetic acid. The gravity difference of the several solutions is sufficient to maintain their complete separation. A piece of iron



Booster station on system of the Oklahoma Pipe Line Company

Keeping Pace

WITH IMPROVED FIELD PRACTICES and ENGINEERING DEVELOPMENTS



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MODEL TD-325

Designed for maximum normal drilling to depths of 9-000-feet. Powered with two (2) Model LRO Waukesha Gas - Gasoline - Butane 6-cylinder, 8½-in. bore by 8½-in. stroke power units delivering 330 h. p. each at 1050 RPM, together with 42-in. Portable Rig Company Reverse Clutch. Maximum pump size for this model is 7¾-in. x 18-in.

MODEL TD-225

Designed for maximum normal drilling to depths of 7-500-feet. Powered with two (2) Model LSU Waukesha Gas - Gasoline - Butane 6-cylinder, 7-in. bore by 8½-in. stroke power units delivering 240 h. p. each at 1050 RPM, together with 36-in. Portable Rig Company Reverse Clutch. Maximum pump size for this model is 7¾-in. x 16-in.

MODEL TD-140

Designed for maximum normal drilling to depths of 5-000-feet. Powered with two (2) Model WOKU Waukesha Gas - Gasoline - Butane 4-cylinder, 7½-in. bore by 8-in. stroke power units delivering 140 h. p. each at 1050 RPM, together with 36-in. Portable Rig Company Reverse Clutch. Maximum pump size for this model is 7¼-in. x 14-in.

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A departure in oil pipe line construction practice — use of couplings throughout at pipe joints

placed in the top solution undergoes corrosion and thereby generates electricity. One terminal of the battery was attached to the copper plate, the other to the iron plate. It has been found that each cell is capable of delivering on short circuit 1.8 amp. with an open voltage of 0.7. Each cask holds enough chemicals and materials for continuous operation over a period of one year. With the use of this method current is produced very economically, its installation is possible at any locality, the batteries can be constructed in any size, and no large cash outlay is required.

Obtaining power for cathodic protection from galvanic potentials between the pipe line and installed anodes is a development embracing the same principle as that just discussed.[7] The Shell Petroleum Corporation has developed the possibilities of this method of pipe protection during recent months. Its most useful field of application is in the prevention of corrosion in "hot spots" of limited extent, such as on deep buried lines, stream and road crossings, etc., where more costly installations would not be practicable.

The procedure is as follows: Sheets of electrolytic zinc (lead free), 5/16 in. thick, are fabricated into 7-in. O.D. cylinders having a ½-in. longitudinal discontinuity to allow for free expansion. The cylinders are 36 in. in length. Each weighs approximately 56 pounds and is provided with a 6-ft. lead, 18 in. of which is soldered onto the inside of the cylinder. Usually the cylinders are installed in batteries of four, one being placed approximately 75 ft. from the pipe line and the others spaced 25 ft. apart and perpendicular to the line. The cylinders are installed in vertical holes 10 in. in diameter and 6 ft. in depth. Fifty pounds of thoroughly mixed salt soil is placed in each hole, to which is added sufficient water to form a heavy mud to a depth of three feet. The zinc cylinder is then placed in the hole and, since it is desirable that as much as possible of the salty mixture be on the exterior of the cylinder, lumps of soil are forced into the cylinder, which in turn forces the salty mixture to the outside. A rubber-covered copper wire connects the four cylinders to the pipe line. Currents leaving the pipe line have varied from 1.0 to 5.0 amp., depending upon the average resistivity of the soil.

As a part of the program of pipe protection manufacturers, as well as engineers of operating companies, are constantly seeking to better existing products when they feel such improvement is needed, as well as to develop new ones to meet certain conditions. Tests being made with rubber-coated pipe were uncovered during the summer and an inspection made to determine the practicability of the idea.[8] More than a year ago two test installations were made on pipe lines in Texas, one on a gasoline line and one on a gas line. Rubber coating was vulcanized at the factory to the sections of pipe used in the tests, leaving ten inches of pipe bare at each end. An unvulcanized rubber sleeve was used to protect the joints at the welds, being first cemented to the pipe and then wired firmly, it being the supposition that in time the sleeve would freeze to the pipe and rubber coating.

When uncovered and examined it was found that the rubber coating applied at the factory was in perfect condition, but the rubber sleeves had not gripped tightly enough to exclude water and there was some evidence of rusting and pitting. In place of the rubber sleeves a new type of protection is now being tried, known as Koroseal coated herringbone tape with a liquid called Koroseal solution used for binding. It is felt by those connected with the tests that if this adequately protects the pipe at the welds the rubber coating will be considered a success for use in "hot spots."

Welding

Improvements in technique and equipment have resulted in greater welding speeds, and increased economies in pipe line welding costs. Use of the all-bell-hole or stab-on method of laying short lines has been one recent development of oxy-acetylene welding practice found to be effective. Welding and laying are accomplished by a single crew, eliminating line-up and firing-line gangs. It has advantages also in instances where reconditioned pipe is employed, since the difficulties encountered in turning crooked pipe are avoided. On longer lines, where the pipe is in good condition for roll-welding, and greater welding speeds are desired, the multiflame method of welding is employed. (See also article beginning on page 68.)

Electric-welding progress has been characterized by the extended use of plain butt joints without backing-up rings on straight-end pipe, replacing the double-bell joint. This provides a simplified type of joint for pipe line construction. In the field of arc-welding equipment, advancement has been made by the development of a remote control device, and a special idling device that slows down the engine of gasoline-engine-driven welders when the arc is broken, thus effecting a saving in fuel consumption. (See also article beginning on page 42.)

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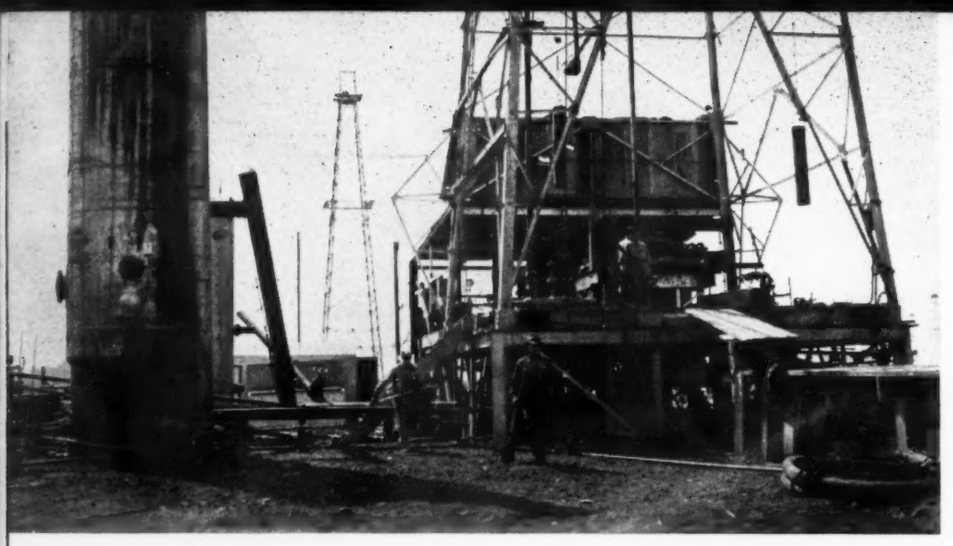

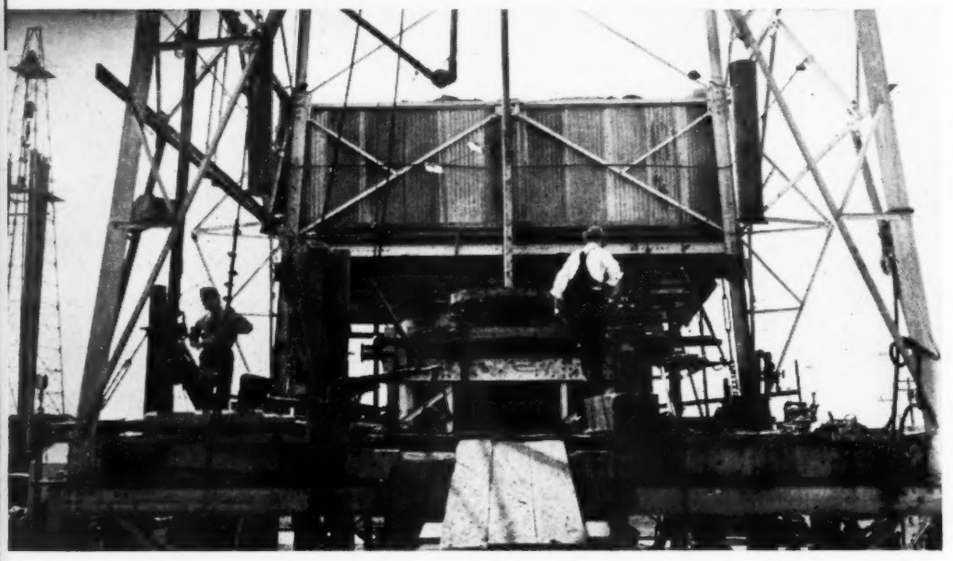

Top—Rotary mounted on special steel structure; used where extra blowout preventer is installed above cross . . . has made elevation of table necessary
Below—Steel sub-base for elevating rotary table. This method dispensed with wooden timbers generally used for blocking up rotary, when such was necessary

By
JOHN S. ROSS

Here is presented a practical discussion of an advanced well-completion practice that has undergone rapid development during the past year

Review of Controlled-Pressure Drilling Method

DRILLING producing formations by the controlled-pressure method is an advanced completion practice now in common use in a number of low-pressure fields. It is replacing the conventional rotary practices in certain high-pressure areas. This method of drilling has undergone rapid development during the past year, and since it has certain important advantages not possessed by older methods, is attracting unusual interest.

All wells in the recently developed Mansion Area of the Oklahoma City field were drilled-in under controlled pressure. The method has also been in use for a year or more in several fields of West Texas and New Mexico. Numerous wells in the Fitts, Crescent, and Edmond pools of Oklahoma were completed under pressure control. This method now is being tried with success in several other districts. In New York State, for example, it has replaced, in some instances, cable tools for drilling-in high-pressure gas wells.

The principal difference between this method and the conventional rotary drilling practice lies in the fact that oil or a mixture of oil and gas is used as a circulating medium instead of mud, and the flow from the well is controlled while drilling is in progress by the use of special control equipment. By means of a packing arrangement between the drill pipe and the casing the flow from the well is confined to a closed system of surface lines and tanks. Thus a well may be brought in "alive" or under a static condition without the usual hazards that accompany the customary completion practices.

Since the wells are drilled in under a "live" or partially live condition, progressive testing of the formations as drilling proceeds permits obtaining a continuous record of the well's capacity to produce. Owing to the higher velocity with which cuttings are returned to the surface by this method the formations penetrated may be logged more accurately; furthermore, the samples are uncontaminated by mud or other foreign matter hence are in better condition for geological examination. This simplifies the work of the geologist and also makes for more accurate logging. During drilling-in the exact position and character of water

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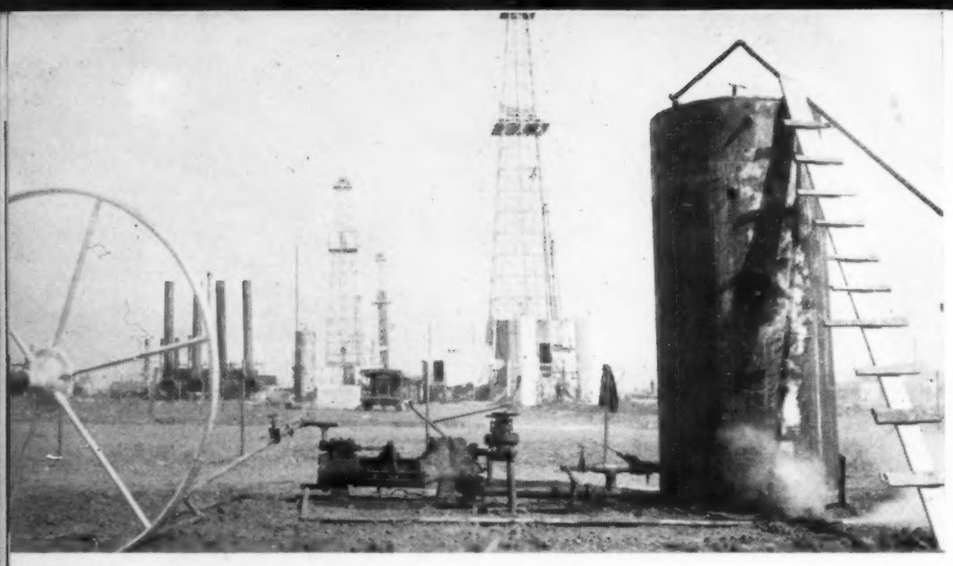


Circulating tank and pump (10 in. by 4½ in. by 10 in.). Tank has capacity of 125 barrels

sands can be determined. In a number of instances traces of bottom water have been detected in time to halt drilling, thus avoiding expensive plugging-back operations.

Experience has shown that there is a noticeable reduction of bit wear and a marked increase in drilling speed while drilling-in under controlled pressure. This is attributed to the fact that the hole is kept clean of cuttings, and also to the high velocity of the circulating fluid and gas in the region of the bit.

It is observed in the Oklahoma City field that the wells completed by the controlled-pressure method require less cleaning-out after they are on production than do those drilled-in by former methods. This is attributed to the fact that during drilling the wells are flowed at their full capacity and all loose sand and cavings from the walls of the hole are cleaned out before the wells are completed.

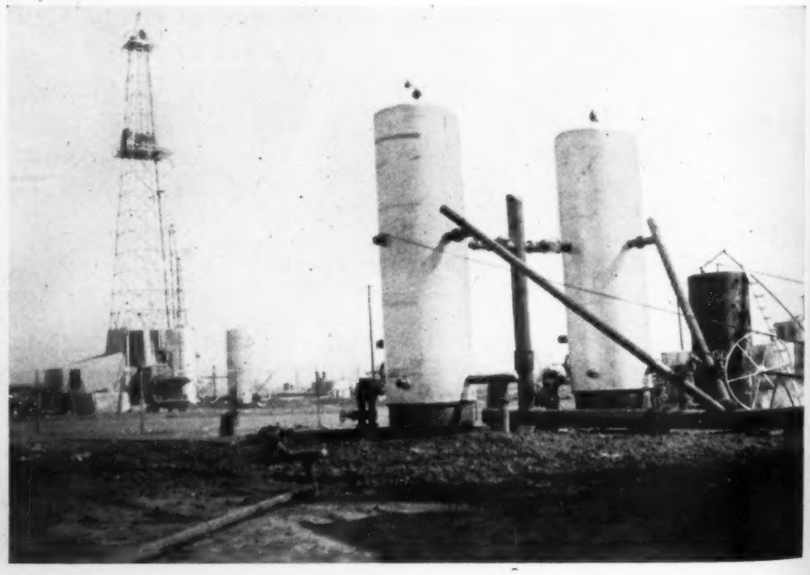
The controlled-pressure method has been applied successfully to the cleaning-out of wells in the Oklahoma City field and in several other pools. It also is used in a few West Texas and New Mexico fields for cleaning-out after shooting.

The operation of the method is dependent upon some form of packing arrangement between the casing and the drill pipe while the latter is undergoing a vertical and a rotational movement. In one method this is accomplished by making use of a round kelly joint and a rubber packing assembly, and in another method by a special square kelly joint packer, used in conjunction with a split rubber oil saver. Both methods have proved successful and are now in use.

One well-known method employs a rotary table that may be raised or lowered by means of hydraulic cylinders. Flush joint drill pipe, supported by slips that engage drive bushings on the table, may be raised or lowered with or by the rotary. The flush joint drill pipe is rotated in and run in and out of the hole through a rubber packing head.

Another method in use employs an assembly consisting of a round kelly joint, a string of flush joint drill pipe, a rubber packing head, and a round kelly driving device. The body of this driving device consists of two halves, which when placed together around the kelly joint form a square that fits in the kelly bushing of the rotary. In the upper part of the body are a series of concave rollers or spools. These rollers grip the round kelly, causing it to rotate with the drive when the latter is rotated. The kelly joint is free to move vertically at all times. The drive is held together by eye bolts and springs, permitting adjustment for the correct pressure of the rollers against the pipe. The round kelly joint is packed off by any one of several types of rubber packing heads. Some of the recently-developed oil savers or blowout preventers employing rubber-faced rams are especially adaptable for this purpose. The advantage of this arrangement lies in the fact that flush joint drill pipe may be run in and out of the hole through a rubber type packing head, or through a blowout preventer if the occasion arises, under relatively high well pressures without leakage and with a minimum amount of wear on the rubbers. By using a round kelly joint and flush joint drill pipe free vertical movement of the drill stem is permitted and the necessity of operating an additional packing unit eliminated.

The square kelly type of packing head consists of a core through which the kelly moves vertically but which is rotated with the kelly. Packing rings inside the core tend to prevent leakage past the kelly and pressure-seal packing placed between the rotating core and its retaining bowl prevents leakage past the core. The bowl is connected to the well by means of a quick union. While this type of packing arrangement permits the use of the conventional type kelly joint, its principal disadvantage is that the vertical movement of the kelly is limited to the length of the joint itself. Drill pipe is run in and out of the hole through a rubber oil saver of the double ram type, placed beneath the kelly packer. The rubber rams in the oil saver must be closed, of course, whenever the kelly packer is removed, such as when making connections and when running



Drilling-in under controlled pressure. This well flowed as high as 500 bbl. an hour while drilling. Its potential production was 27,998 bbl. daily

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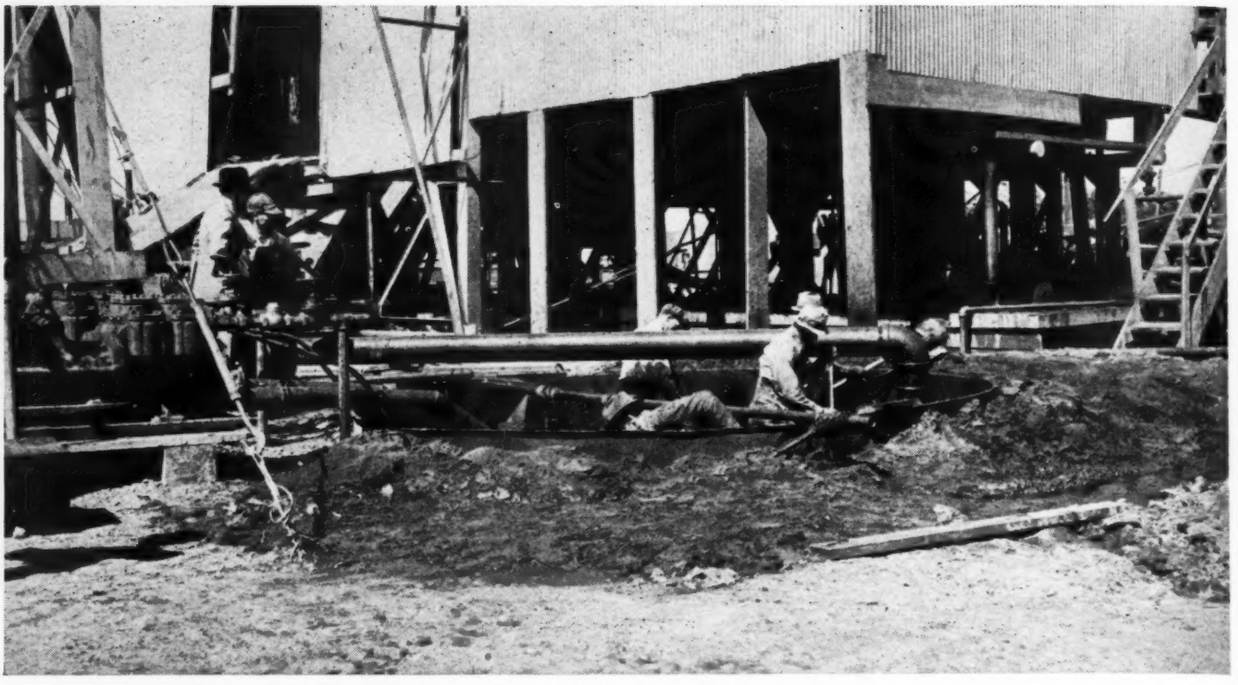


Sand and some oil are drained from separator while drilling-in under controlled pressure. The oil is picked up and pumped to circulating tank or back into separator

drill pipe. This type packer is used mainly in connection with regular exterior-coupled drill pipe. The rapid wear of the rubber due to the passage of the tool joints through the oil saver while running drill pipe is quite an expensive item of this method.

Regardless of the type of packing arrangement used, all controlled-pressure drilling operations require a certain amount of special preparation and auxiliary equipment, depending upon local field conditions. In the Oklahoma City field, for instance, it is the common practice to install a blowout preventer below the cross. The blowout preventer is placed in this position on the well as a precaution in event the cross cuts out, which is very apt to happen where large quantities of sand are produced. The city ordinance requires two master gates in the cellar. The use of two master gates is especially valuable where large quantities of sand are produced. One of these gates may be held in reserve while the other is closed for the removal of the bit. In high-pressure fields, such as Crescent, it is the custom to install two blowout preventers, one below and one above the cross.

If derricks are erected on substructures it is possible to install all the necessary control equipment beneath the derrick floor; however, if substructures are not provided it may be necessary to block up the rotary. This has been done successfully in some instances to as high as nine feet.

It is the customary practice to provide a circulating tank of about 100 bbl. capacity, which is connected to the oil and gas separator and to the circulating pump. In high-pressure fields and in operations where only oil is circulated, the regular rotary mud pumps may be used; however, in fields where the formation pressure is relatively low and the pay sand lies at great depth, and only small quantities of oil are circulated in conjunction with injected gas, mud pumps have been found unsuitable. Under such conditions a smaller pump is installed for circulating the oil. In the Oklahoma City field a 10 by 4½ by 10-in. pump is found to be best suited for this purpose.

Most controlled-pressure drilling operations require high-pressure gas, either for "kicking off" the well or aerating the circulating oil column. The high-pressure gas connection is made at the bottom of the stand pipe in the derrick. In addition to the check valve ordinarily placed in the gas line, one also is installed in the oil line between the stand pipe and the circulating pump. This eliminates the hazard of gas-locking the circulating pump. A steel hose with multiple swivel joints is generally used, as this type of hose is preferable to the regular rotary hose because the oil and gas used in circulation is likely to cause deterioration of the rubber lining.

Since one of the main objectives of this method is to gain all possible information of underground conditions, operators find it advantageous in most instances to meter both the input and output volumes of gas, and to gauge the oil produced while drilling. Often Pitot tube measurements are relied upon to give the desired gas information, particularly if no gas is injected into the drill pipe. Many operators provide some means for collecting samples from the flow line leading to the separator. One operator in New Mexico uses an ingenious sample catcher consisting of a nipple that drops down from a tee in the flow line, and two valves. A baffle in the flow line just beyond the tee causes cuttings to drop into the nipple, from which they are removed by closing a top valve and opening a bottom valve.

Although the details of operation vary somewhat in different fields, depending upon local conditions, the general procedure followed is very similar. The well is drilled down to the point of casing in the usual manner with mud, and the casing cemented. While the cement is setting the necessary preparations are made for drilling-in under controlled pressure. The control equipment is installed and all surface connections are made. The oil and gas separator is set up on its permanent location, lease storage tanks erected, and all the usual arrangements made for bringing in a new well.

The procedure in the Oklahoma City field is typical of that followed in more than a hundred operations in this

area and consists of drilling out the cement plug in the customary manner with mud, the mud then being replaced by clear water. The drill pipe is pulled out, a fresh bit put on, and the water blown out in stages as the drill pipe is run in. When the bit is on bottom circulation of oil and gas is established. The initial rate of circulation in this field varies from 20 to 30 bbl. of oil an hour. The pressure of the input gas is approximately 600 lb. per sq. inch. Oil is picked up soon after penetrating a gas cap in the top of the Wilcox sand and increases with further drilling of the sand. Frequent oil gauges and gas measurements are made to determine the production rate at various depths, and often one or more potential production tests are made before the well is finally completed. Every effort is made to maintain natural flow during drilling and to bring the well in "alive." Wells that will not flow upon completion are tubed and put on gas-lift, the tubing being run through an ordinary rubber oil saver.

It is not always necessary to "nurse" the wells along in order to maintain natural flow during drilling as in the Oklahoma City field. In this field, the Wilcox sand, lying at a depth of 6300 ft., has a bottom-hole pressure of less than 500 lb. per sq. in., and the wells are easily killed with dead oil. In the Fitts field, the formation pressures are sufficiently high to cause the wells to flow continuously while drilling is in progress, even though considerable oil is circulated.

In the Eunice field, New Mexico, only oil is circulated while drilling and the wells remain in a static or semi-static condition when loaded with dead oil. However, a slight aeration of the oil column by the injection of gas causes the wells to commence flowing. The wells are unloaded in this manner and production tests are made of the various probable productive strata. By maintaining an accurate record of the production and by carefully logging the character of the formations, operators find it possible to determine the position of the most prolific strata in the lime section.

A number of wells in the Crescent field, Oklahoma, are being deepened under controlled pressure to the lower member of the second Wilcox sand. The bottom-hole pressure of this lower sand is approximately 2400 lb. per sq. inch. Oil is used as the circulating fluid and when the bit penetrates the sand the wells begin flowing at a high rate, continuing until drilling is completed and the well shut in. Rates of flow of as high as 1200 bbl. an hr. during drilling are not uncommon.

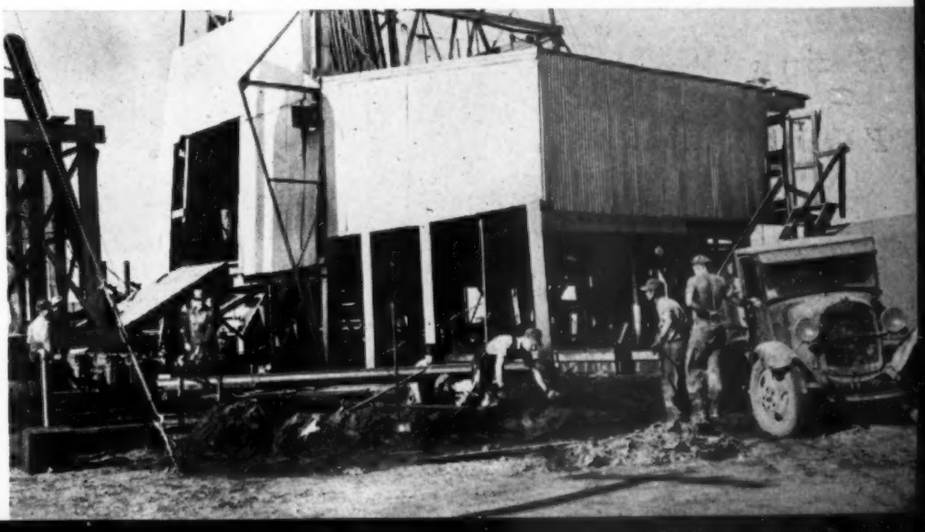
It is interesting to note that when operators first turned to this method of drilling-in producing sands, it was the general opinion that the operation would have to be carried on under relatively high back pressures. This has not been found true, even under conditions where the flow is very great. If ample separator capacity is provided, flow lines of the proper size are installed, and sufficient tankage is available, it is found unnecessary to drill under a surface back pressure that is in excess of the normal operating pressure of the separator. Under these conditions flowing pressures seldom exceed 100 lb. per sq. inch. The friction due to the casing and drill pipe in the hole tends to reduce the rate of flow to the extent that one, and in exceptional cases two, separators can handle adequately the production without excessive back pressure on the surface fittings and the control equipment. This condition, of course, holds true for flowing pressures only, for if such wells are shut in at any time during drilling, high pressures might be expected. Stop-cocking or choking of the flow at the surface during drilling is not practiced, the general custom being to allow the wells to flow unrestricted. It is found that excessive back pressures when applied at the surface reduce the velocity of the rising column of oil and gas to the extent that its carrying power is lost and cuttings settle out. It is the practice in certain high-pressure fields, however, to control the rate of flow to some degree by pumping and circulating dead oil. In this manner back pressure is applied to the bottom of the hole, thus forcing the reservoir pressure to expend more energy in raising the denser fluid to the surface.

It is rarely necessary, even in the case of very large wells, to snub in or out of the hole more than one stand of drill pipe while the well is flowing, provided the restriction caused by the bit is not great enough to create an abnormally high pressure beneath it. By exercising care, it is a simple matter to snub one stand of drill pipe by making use of the cat line or a truck winch. The experience gained in this connection within the past year allays some of the fear expressed by operators that it might be necessary to kill large flowing wells completed under controlled pressure in order to withdraw the drill pipe and bit.

Another fact not generally recognized is that where drill pipe can be run in and out of the hole through rubber type oil savers or strippers in large flowing wells, as is the present practice, tubing likewise can be run in and pulled with even greater ease. Consequently many operators now run tubing under low flowing pressures before the drilling rig and control equipment are removed instead of having it snubbed in against shut-in pressure after the well is completed.

Although the controlled-pressure method of completing wells has been found applicable to fields where the underground strata are relatively hard and capable of standing up in open hole, its application in areas where the hole penetrates great thicknesses of unconsolidated and loosely-cemented formations is still questionable. Possibly through the control of the density and the velocity of the circulating fluid and of the application of regulated back pressure, the method may be adapted to the drilling-in of wells in the Gulf Coast and the California fields, where conditions for this method of drilling are now considered less favorable.

Experience to date has demonstrated that this method is of particular value for drilling-in and completing low-pressure wells and for obtaining more accurate information regarding underground conditions.



Cuttings and sand bled from separator being shoveled from sand pit into truck. The sand tank, 18 ft. diameter by 4 ft. deep, is made from bottom of old steel oil tank and is sunk in ground

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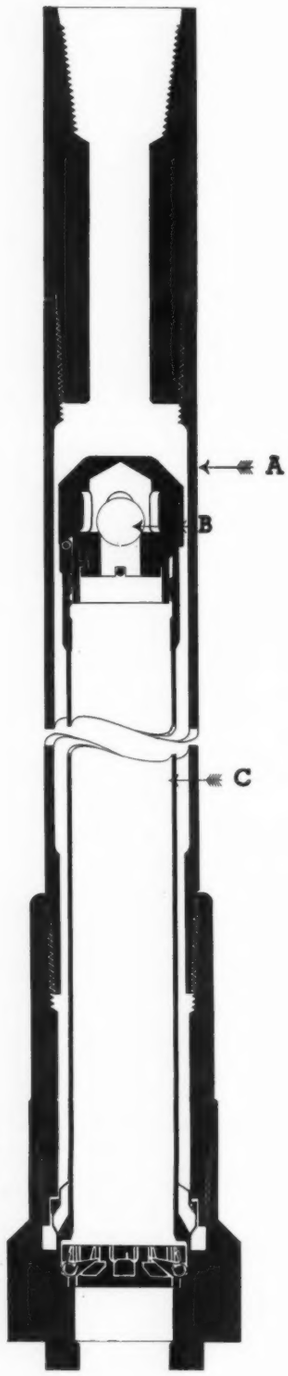

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FOR LOOSE FORMATIONS, THIS CATCHER with long dogs serves to close the Inner Barrel and prevents the core from sifting out while coming out of the hole. A combination of these two dog type core catchers is often used with remarkable success.

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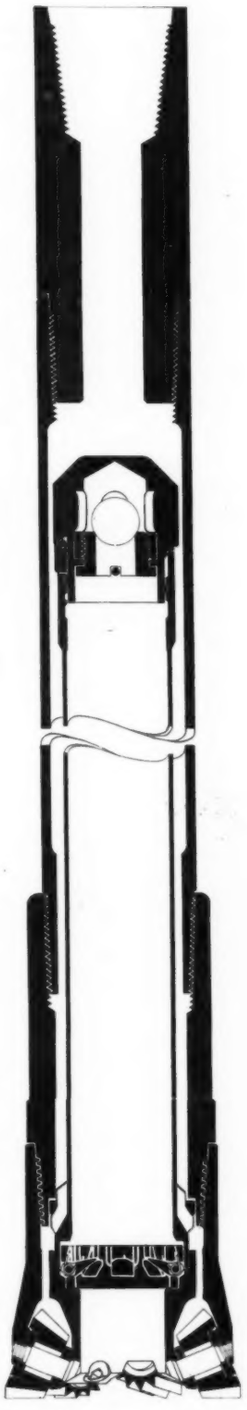

HARD FORMATIONS ARE EASY TO CORE with this head. Four outer cutters and two inner cutters produce a smooth-running bit, and as the outer cutters do the most work, maximum footage per head is assured.

All heads have roller bearings except the smallest sizes, which have plain bearings of extra hard, abrasion-resistant material. The one-piece heads are not subjected to welding after heat-treating, so that the full strength of the alloy steel is retained.

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HERE'S THE SLIP-TYPE CATCHER that pulls HARD CORES, even if they are difficult to break off and to hold. As the core enters it first contacts the spring fingers, lifting the lower ring and forcing the slips upward in the tapered ring. In this position the supporting springs connecting the slips to the lower ring hold the slips back in their recesses so that they do not interfere with the core.

The entire catcher is **free to stand still with the core** because the slips bear only against the "floating" slip ring, and the catcher holds the core while the barrel revolves around it. When coring is completed and the barrel is lifted, the lower ring is pulled down away from the slip ring and wedges the slips solidly against the core.

The core, as it enters the barrel, cannot get back of the slips to break them off or to force them toward center and block off the opening into the inner barrel.

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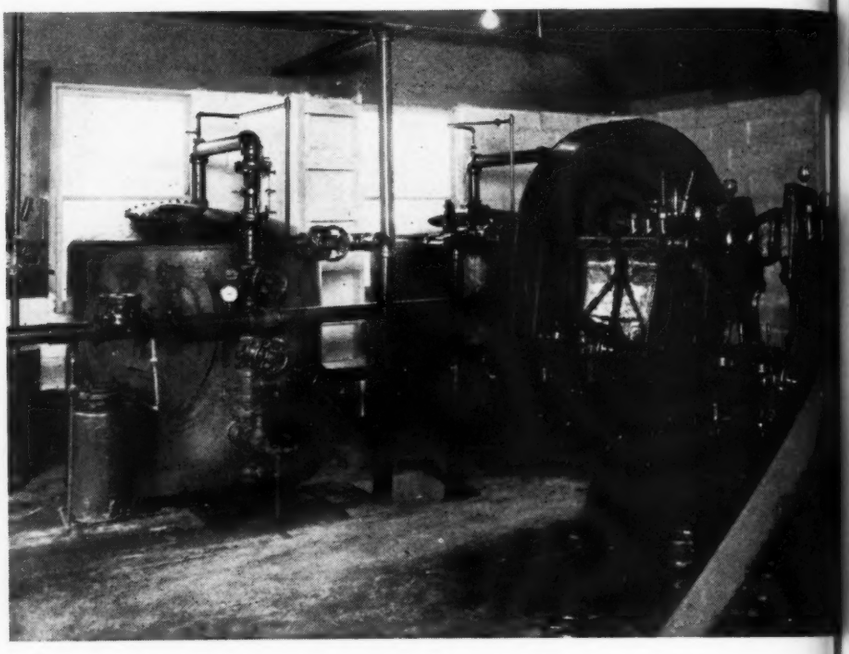
Left—Direct-connected engine driving triplex pumps

Below—Electric motor driving triplex pump, and filters in Bradford field pressure plant



Recent progress in water-flooding methods, a subject of vital interest to all stripper well operators seeking means of preventing abandonment of leases after production by natural methods has become uneconomical

Recent Developments in Water-Flooding Practice in the Bradford Field

By A. C. SIMMONS*

IT is the hope of every stripper well operator that a water-flooding method, or some similar modified system, can be used to prevent the abandonment of leases where production by natural methods has become uneconomical. As the Bradford Field in Pennsylvania and the Allegany Field in New York State are obtaining their present oil production almost exclusively by the application of water-flooding methods, it is quite natural that stripper well producers should be interested in new methods and technique that have been evolved or developed in those areas.

The fundamental principle of producing oil with a forced water drive is of long standing and the mechanics of the process are reasonably well understood; however, new but not wholly radical developments are continually taking place and the writer will endeavor to outline some of the more recent ones used in the Bradford and Allegany fields.

During the past year or two few, if any, marked changes have been made in general field practice; however, there has been steady progress and such developments now are commonly accepted by engineers and technologists. To others that are interested but not actively engaged in this method of oil

*Geologist and Petroleum Engineer, Bradford, Pennsylvania.

For Drilling in, Tubing and Packing HIGH-PRESSURE WELLS

New "Type G" Guiberson Control-Head Packer

Type C-2 High-Pressure Tubing and Drill Pipe Oil Saver, for Working Pressures up to 600 Lbs.

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The new GUIBERSON Type C-2 and Type D High Pressure Oil Savers were designed in answer to a definite DEMAND on the part of leading producers and contractors.

Both types are of one piece, all steel construction to withstand the high pressures sometimes encountered in drilling in wells under pressure. The Type C-2, having a through opening of 10", which will pass anything up to that diameter, is tested for 1200 lbs. hydrostatic pressure and is recommended for working pressures up to 600 lbs., while the Type D, having a through opening of $7\frac{1}{16}$", is tested for 3000 lbs. and recommended for 1500 lbs. working pressure.

Suitable adapters can be furnished with either type to fit in any kind of hook-up.

Type D High-Pressure Tubing and Drill Pipe Oil Saver, for Working Pressures up to 1,500 Lbs.

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Types C-2 and D Oil Savers are ideal for tubing wells under pressure, as is the Type B Oil Saver, which has a split cast steel housing and is designed for working pressures up to 400 lbs., and has a through opening of 8".

All GUIBERSON Oil Saver Rubbers are of a durable oil-resisting compound, designed to allow passage of tubing and drill collars with no leakage.

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For setting tubing in flowing wells and packing off between tubing and casing, the GUIBERSON Oil Saver of the proper capacity and the GUIBERSON Control Head Packer are recognized by producers as unequalled. Our Type G Packer offers several important improvements. The new "Duprene" packing is unaffected by oil and gas, is more durable than rubber and will not stick to the casing wall. The two narrow rubbers in place of one wide one assure a tight pack-off under all conditions. Dovetail slip construction insures accurate alignment and operation.

For full details on oil savers and packers, see your supply house, ask for special bulletins or consult the Composite Catalog, pages 547 to 574.

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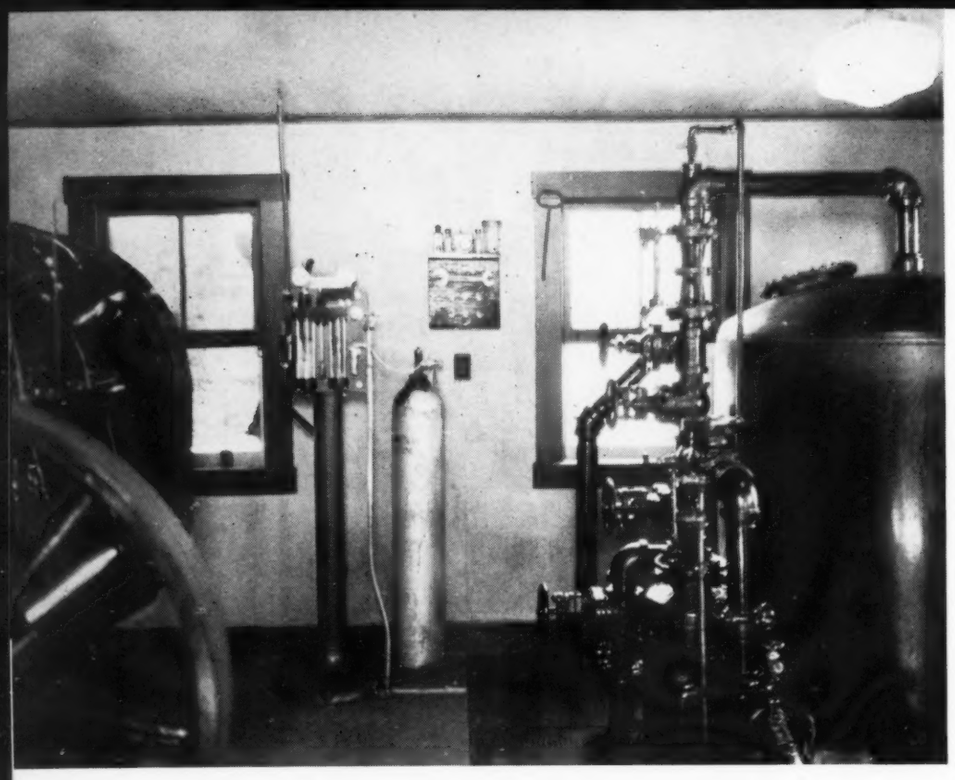


Chlorinator and filter for treating flood waters

production many of these innovations no doubt will be of interest.

The drilling pattern known as a "five spot" was first used in 1927 and, with a few minor exceptions, this form or pattern for drilling wells is still the most commonly used system. Well-spacings on the side of a five-spot square have been gradually widened until at the present time the average well-spacing in the Bradford field is 300 ft. to 325 ft. (water to water). These increased spacings have resulted in much lower development costs per acre for the reason that fewer wells are required. The rate of recovery with the increased spacing is lower, unless compensated for by greatly increased water pressures, and the trend is to a wider well-spacing and the application of higher water pressures.

The use of wider well-spacings and higher water pressures has increased the duty or load on all machinery and equipment and consequently there has been a progressive but gradual change to heavier and stronger mechanical equipment. This change toward heavier equipment is applicable to nearly all surface equipment, such as jacks, shackle lines, powers, pumps, engines, belting, etc., and is of sufficient effect that installations being made in 1936 are much larger and more durable than installations of a few years ago.

Fuel Problems

The statement often is made that gas used for fuel is rapidly dissipated under conditions of intensive five-spot flood development. Such a statement is untrue because in a flood development there is no destruction of gas reserve but a more rapid depletion of the available gas contained in the sand. Together with this higher rate of depletion are greater fuel requirements due to higher horsepower loads in an intensive development, and there exists today a fuel problem on the majority of leases in the Bradford and Allegany fields.

This lack of sufficient lease gas to carry out the operations requires the purchase of fuel, and there are but few intensive flood developments where natural gas, fuel oil, or electricity are not being purchased to supply the horsepower requirements for water and oil pumping. A comparatively recent innovation is that of arranging a vapor-recovery system whereby natural gas dissolved in the oil can be recovered from both stock and receiving tanks and used as fuel. Such vapor-recovery systems are not new, since they have been used in refineries and gasoline plants for many years, and it is the writer's opinion that such gas saving or recovery systems will be common practice in water-flood areas in the near future.

The Examination of Cores

More and more interest is evinced in the use and interpretation of core analyses reports, for the reason that, as the expanion of flood development continues, the lower-grade properties are more favorably considered and almost every one is interested in the possibility of exploiting the less productive areas. Where the operation and development of the lower-yield properties are involved it is even more essential to conduct the operation in the most efficient manner, and the information gained from cores and the interpretation of the analysis frequently are invaluable. Core reports also have been valuable aids in the prevention of uneconomical development, for many instances have come to the writer's attention where a new five-spot development was contemplated in a thin-sand area and the core information was such as to discourage the project as a definitely unprofitable development.

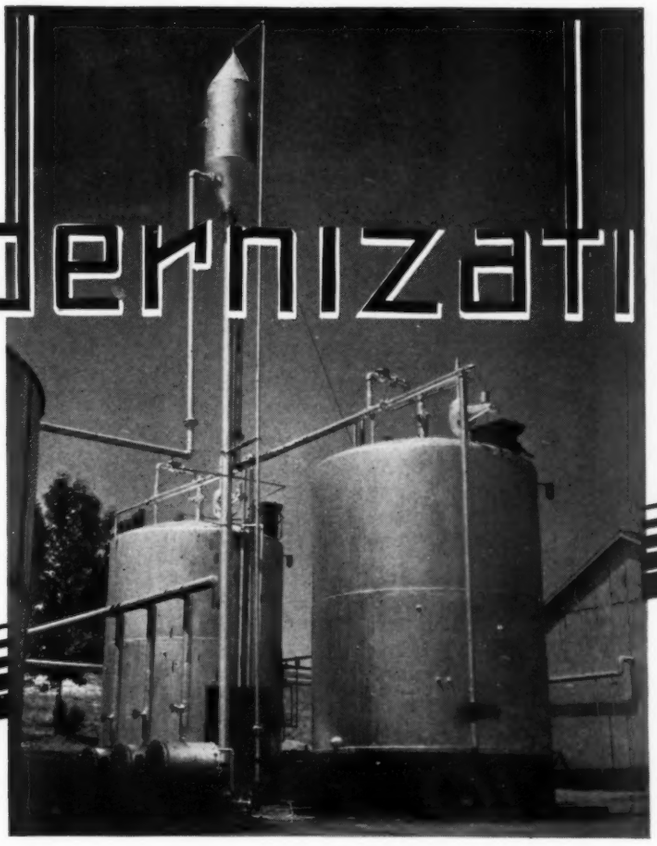
Water Supply Problems

Insufficient water supply has existed in the Bradford and Allegany fields for a number of years, but recent dry seasons, together with greater water requirements, have aggravated this condition to a degree that it frequently represents a serious obstacle in the development of a lease. There are three possible solutions to the problem. First, the purchase of water from a commerical water company; second, to complete and operate water wells at some distance from the existing wells, and where oil property water requirements are situated near the boundaries of the field it is common practice to go beyond the limits of oil production to obtain an adequate water supply, particularly in nearby valleys where withdrawals have not been excessive. The third possible solution is to develop and exploit water-bearing strata that have not been used previously. This is accomplished by developing "gravel wells" in the sandy gravel formation above the bed rock and represents a new and distinct change in the principle of obtaining a ground water supply. Previous practice was to case a water well to bed rock and complete the well by drilling through the ground water strata to obtain water from the fractured rock zone, or what is frequently termed a "rock well." The overlying gravels are not ideally suited to the development of water wells, but many satisfactory wells have been completed in the gravel and sand that comprise the valley filling material.

Water filtration was an innovation only a few years ago, whereas it now is an accepted and standard process and most of the water used in the Bradford and Allegany fields is filtered through pressure filters. It is generally realized, however, that filtration is not the "cure all" for water problems and, while filtration of flood water is almost universally beneficial, there are many instances where such treatment is entirely inadeqaute.

The next and most logical step in

Modernization



IMPROVES PERFORMANCE CUTS TREATING COSTS

Tremendous strides have been made in the art of dehydration during recent years as a result of the research and development work continuously carried on by the Petreco engineering and laboratory departments. While flow-line treatment is one of the major developments, the majority of improvements are applicable to any type of Petreco electric dehydrator irrespective of operating conditions.

Operators should give serious consideration to the modernization of dehydrating plants of both the flow-line and batch treating types, thereby taking full advantage of all the improvements available. This procedure will assure the widest range of utility, improved performance and results, automatic and more efficient operation and control, as well as considerably reduced labor and overall treating costs.

Petreco engineers will check equipment, methods and costs and give accurate estimates of the improved performance and savings possible through modernization of existing plants. Their services are available on request without obligation.

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LOWEST "CUT" HIGHEST GRAVITY MAXIMUM PRICE

water treatment is that of adding chemicals to the water to correct undesirable characteristics, and such treatment is becoming more common. The first chemical treating plants were looked upon with considerable skepticism but their operation has been so successful that certain types of chemical feeding equipment now are widely used and advocated as being a vital part of flooding practice. Probably the major correction to natural water is that of reducing its aggressiveness or corrosive tendencies and is usually referred to as pH control. Some natural waters in the Bradford and Allegany fields possess low pH values and that, coupled with a deficiency of scale-forming mineral salts, creates a condition in the water pipe line systems of extreme corrosive action, and the products of this corrosion frequently are carried into the oil sands, resulting in plugging of the sand pores. The protection of pipe lines to prevent replacement does not present a serious problem, as this corrosion, in all probability, is not severe enough to create a condition that would necessitate the high-pressure distribution lines having to be replaced during the life of a flood development. The principal objection to the corrosive action on the pipes arises because of the contamination of the flood water by the products of corrosion and the introduction of a dirty water to the oil sands.

The corrosive action of water can be corrected in a number of ways, but the simplest and apparently most desirable is that of adding, by automatic feeders, small quantities of lime, since the material is inexpensive, and if the machinery is properly installed and operated there is little or no probability of detrimental results. Feeding lime in this manner has been highly successful and is becoming a part of standard flooding practice.

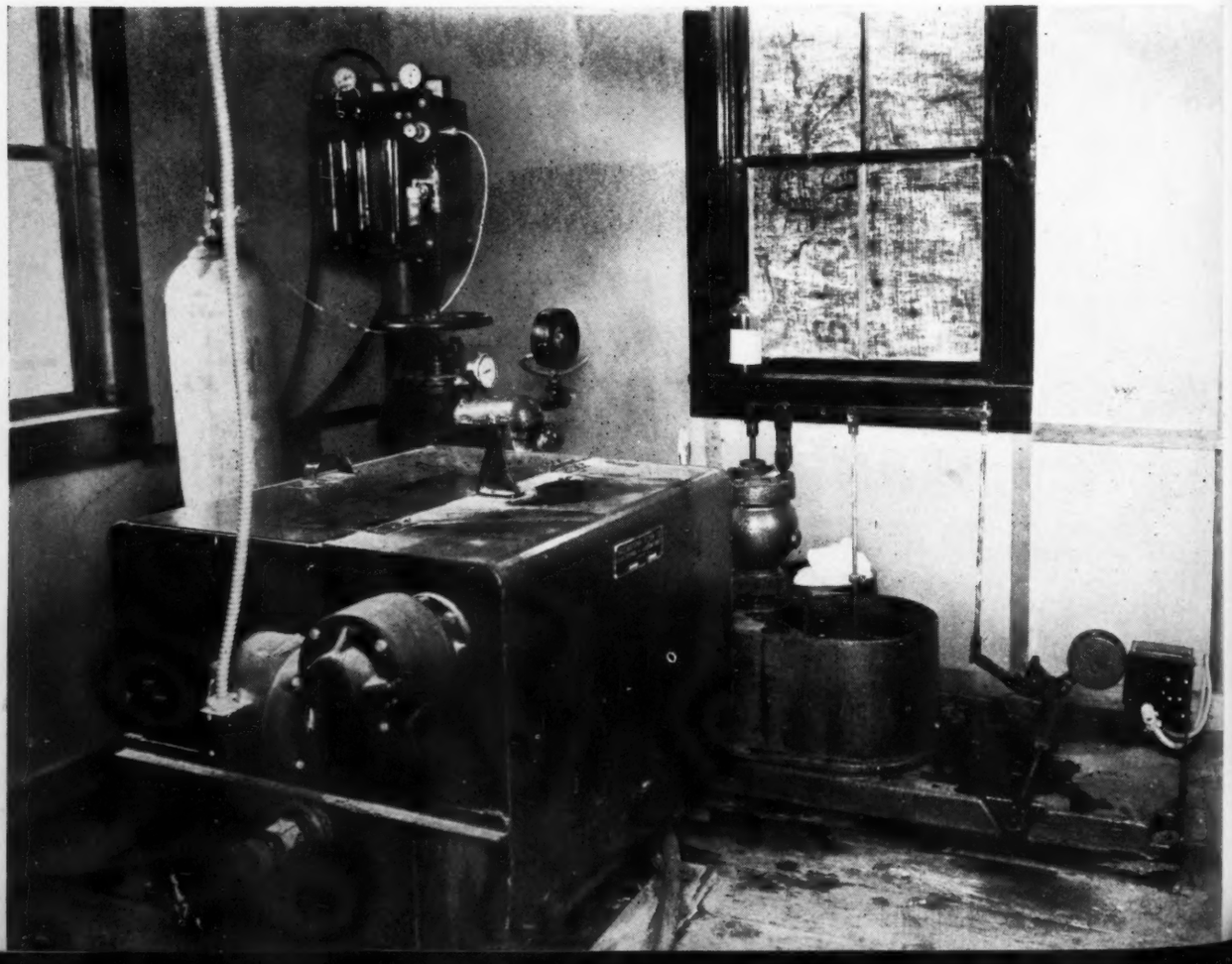
In addition to water treatment to correct corrosiveness, a new development has been introduced recently—chlorination of oil field flood water. It has been recognized that organic growths are harmful, and considerable time and effort have been expended on ways and means of preventing or removing such growth. The most effective way to correct undesirable organic growths in water is that of chlorination, and the installation and use of chlorinating equipment have been accelerated in the last two dry seasons primarily because of the fact that inadequate water supplies have developed a more serious condition tending toward the formation of algae in water tanks, pipe lines, and wells.

The writer is familiar with chlorinator installations where the cost of installing and operating the chlorinating equipment will be quickly repaid by the increased life and usefulness of filter beds, for previous to the installation of the chlorinating equipment it was necessary frequently to replace filter beds because of accumulation of algae growths in the filter that result in subsequent matting and plugging of the filter beds.

The chlorination of water for flooding purposes has a great many advantages and few disadvantages, and where a water condition exists that requires control of algae growth it appears that some system of chlorination is highly desirable and beneficial.

Solution of water-flood problems have been a gradual evolution to more efficient and effective methods rather than sharp changes in original principles. The proper and economical solution for many existing problems will come gradually, and it appears probable that the greatest technical advantages to be realized will be in the realm of water-conditioning, or the treatment of flood water to yield increased oil recoveries.

Automatic chemical feed equipment for water treatment

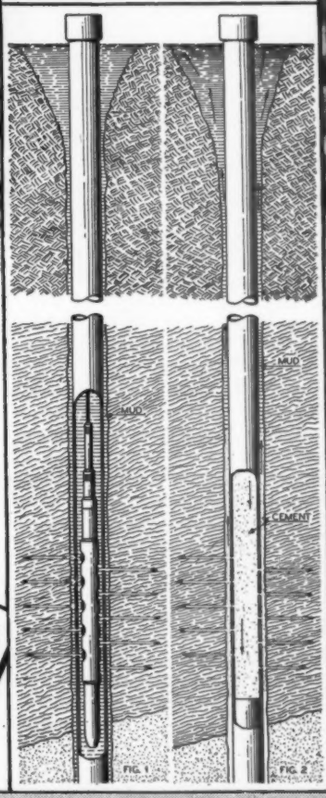


TO SAVE A CRATERING WELL-

Gun Perforate AND CEMENT

Figure 1—Shows well killed with rotary mud, Gun Perforator in position and ten shots completed.

Figure 2—Shows plug in position below perforations, and cement being pumped through holes to displace rotary mud and make permanent gas shut-off.



Says "Perforating Pete":

"There's only one thing to do to shut off the gas in that well and stop the cratering: Have us Gun-Perforate about half way down, then float down a plug and do a cement 'squeeze' job.

"One of our customers had similar trouble just the other day, with a terrific volume of gas blowing up outside the casing from well bottom, which was in open hole at 5000 feet.

"They killed the well with rotary mud, then called us in and had us Gun-Perforate ten holes at 2500 feet. Next they floated a plug to a point just below the perforations, and kept the pressure on until the rotary mud began to flow in the surface crater.

"Finally, they pumped cement through the perforations until it displaced the mud and completely filled the crater. This did the trick—the cement set okay and the gas shut-off was perfect!

"Your well conditions here are similar, and there's no reason why we can't help you out of this mess. Let's go!"

NO 8 ... OF A SERIES OF GUN PERFORATOR APPLICATIONS ...

Devices and method of operation licensed by Technicraft Engineering Corp. under Patents No.—1,582,184; 2,029,454; 2,029,478; 2,029,490; 2,029,491; 2,033,562; 2,043,340; 2,043,341; 2,043,400; 2,043,401.

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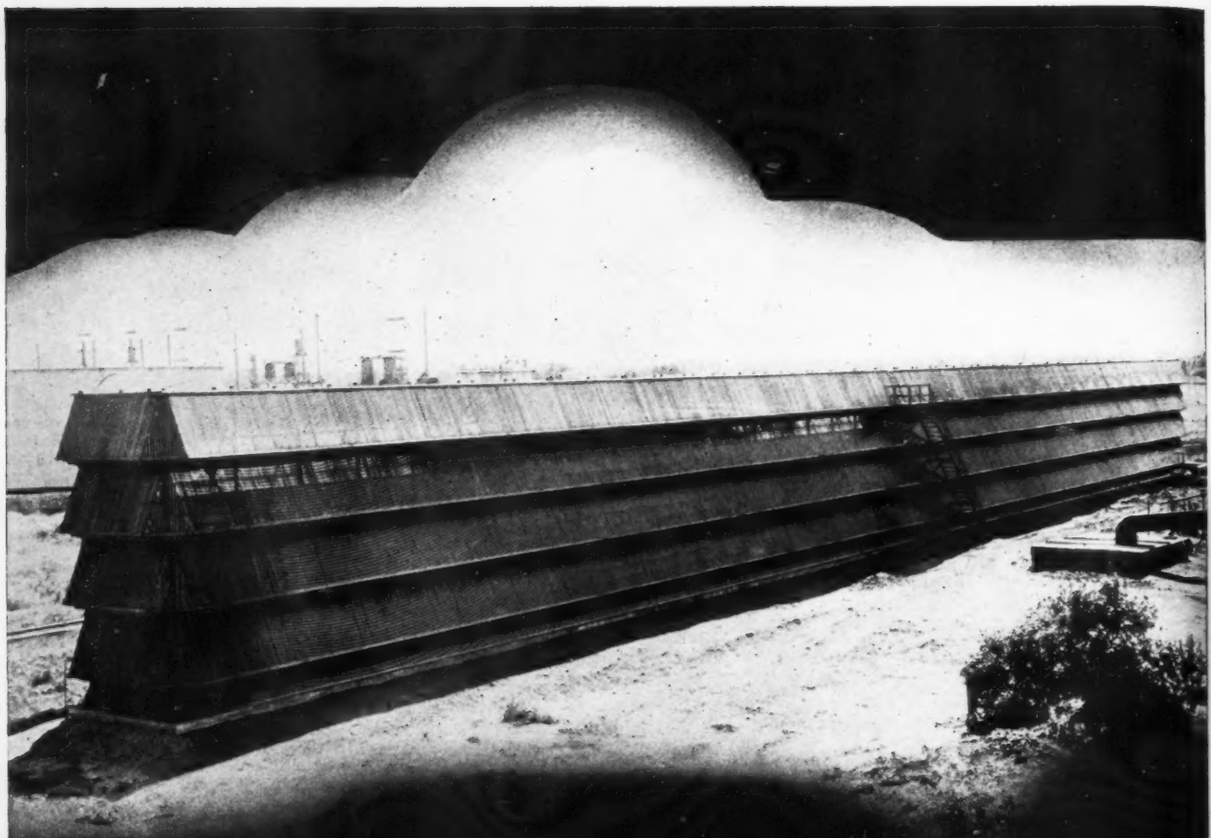

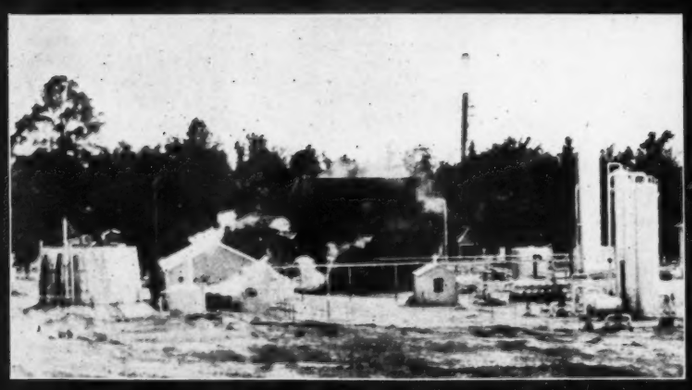

Annually more Marley water cooling equipment goes into service than any other kind. Marley design, Marley materials, Marley engineering and Marley workmanship have been proved by the test of time.

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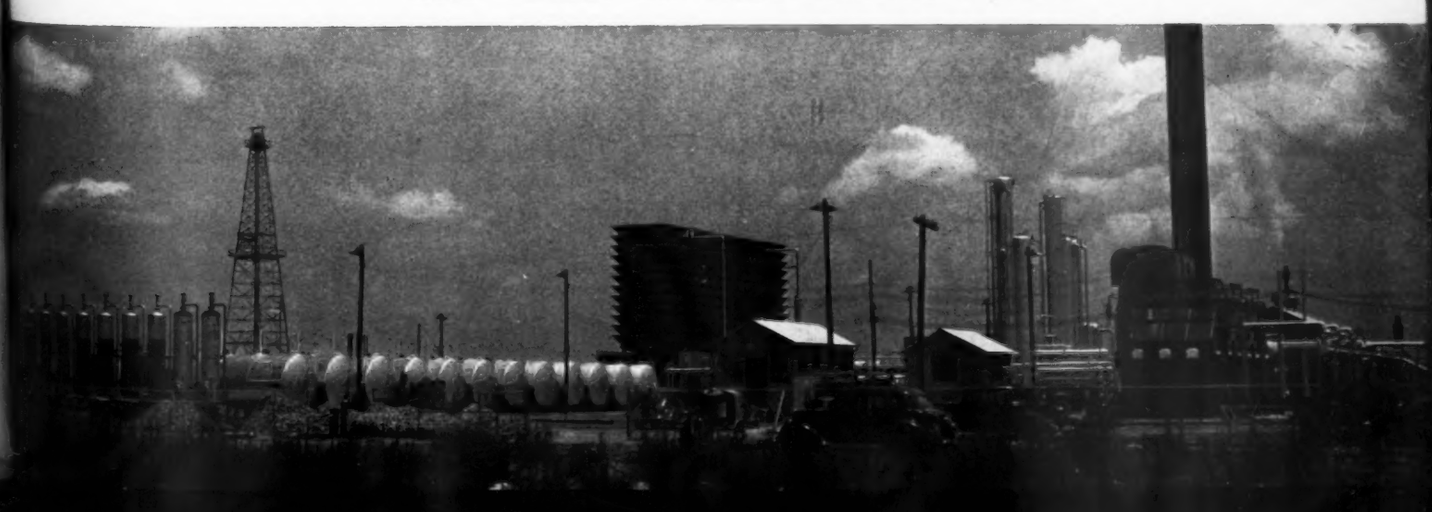
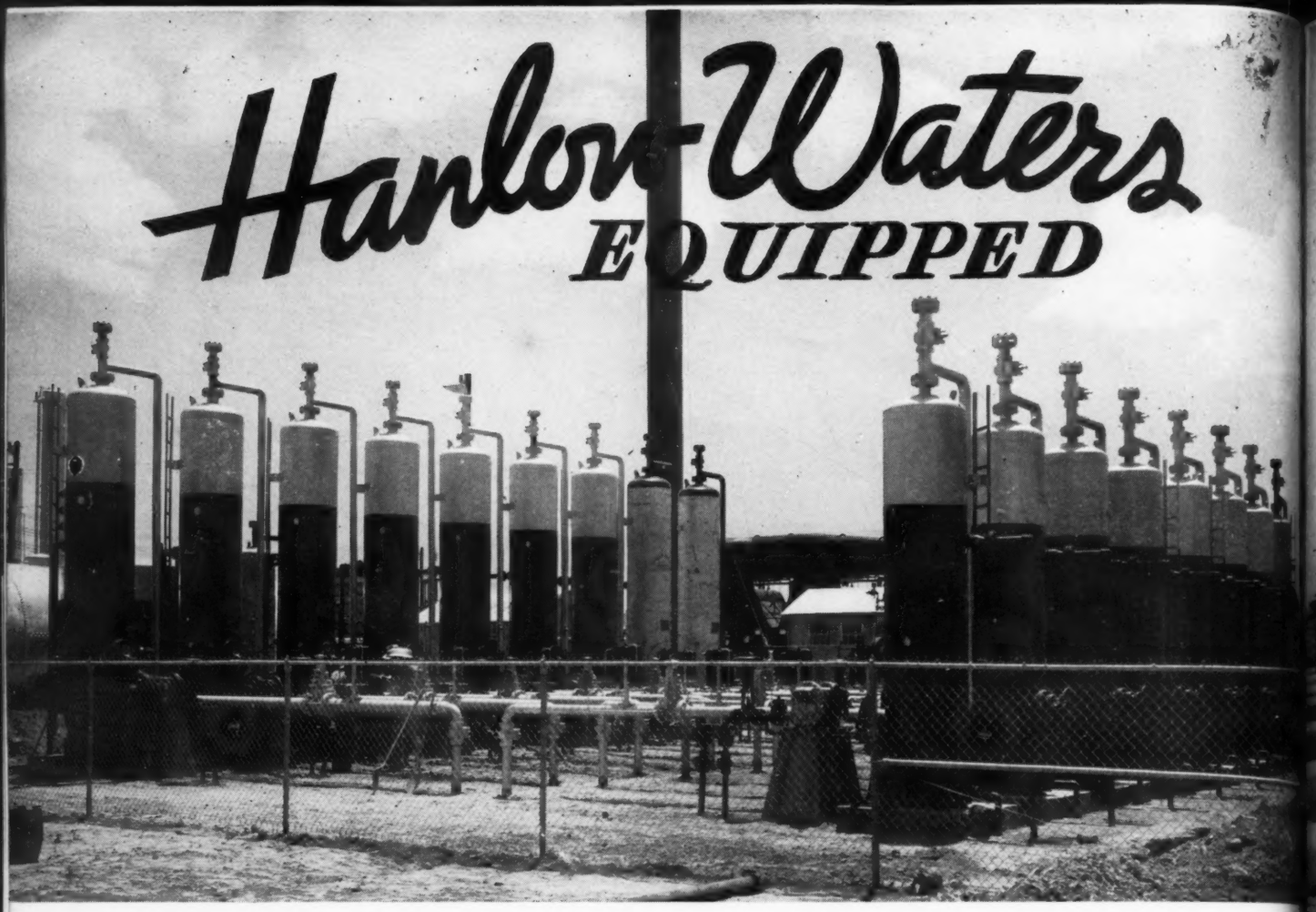
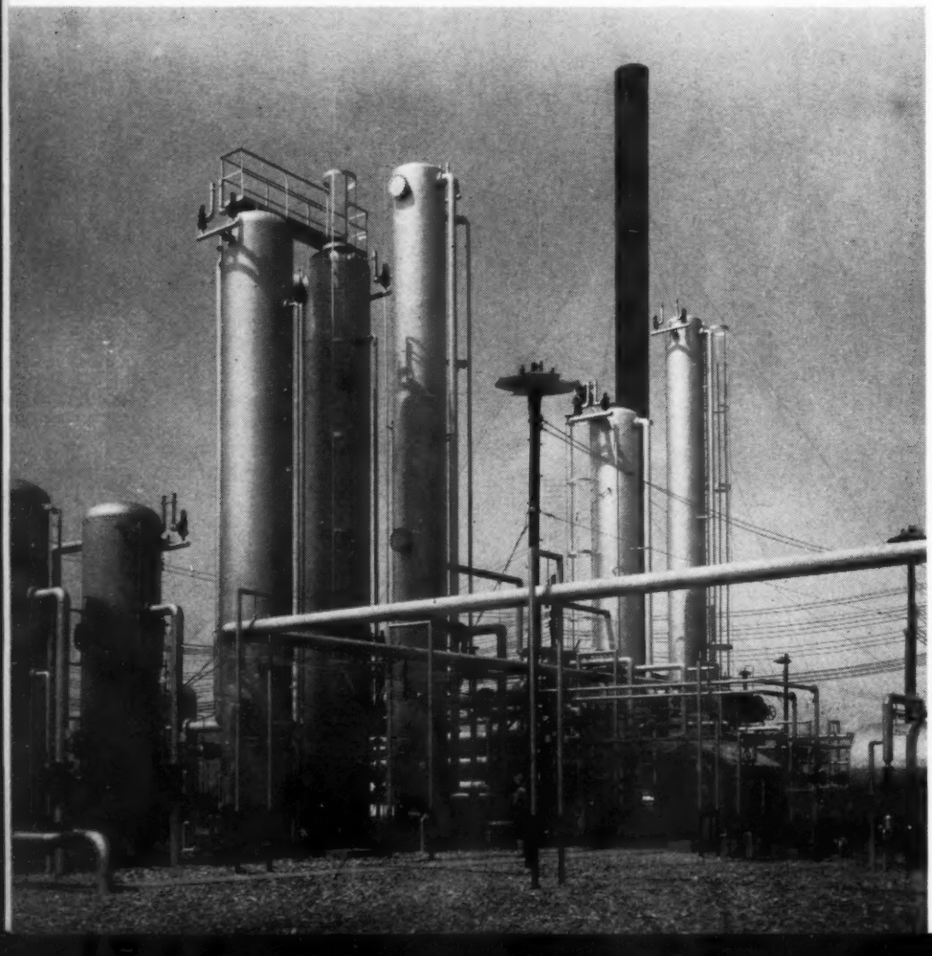
The industry's most modern Gasoline Recovery and Crude Oil Stabilization Plant.



Hanlon-Waters EQUIPPED



Partial view of a battery of high-pressure HANLON-WATERS Oil and Gas Separators, one for each lease. This is a unique installation of oil and gas separators, because, contrary to usual field practice, the separators are installed at the gasoline plant with flow lines leading to each well, rather than installation of the separators on the lease adjacent to the well with flow line leading from the separator to storage tanks.



Lower left and right photographs show partial views of the HANLON-WATERS Automatic Liquid Level and Pressure Control Equipment in service on this plant of the Continental Oil Company in the Tepetate Field.

HANLON-

NATIONAL BANK OF TUL

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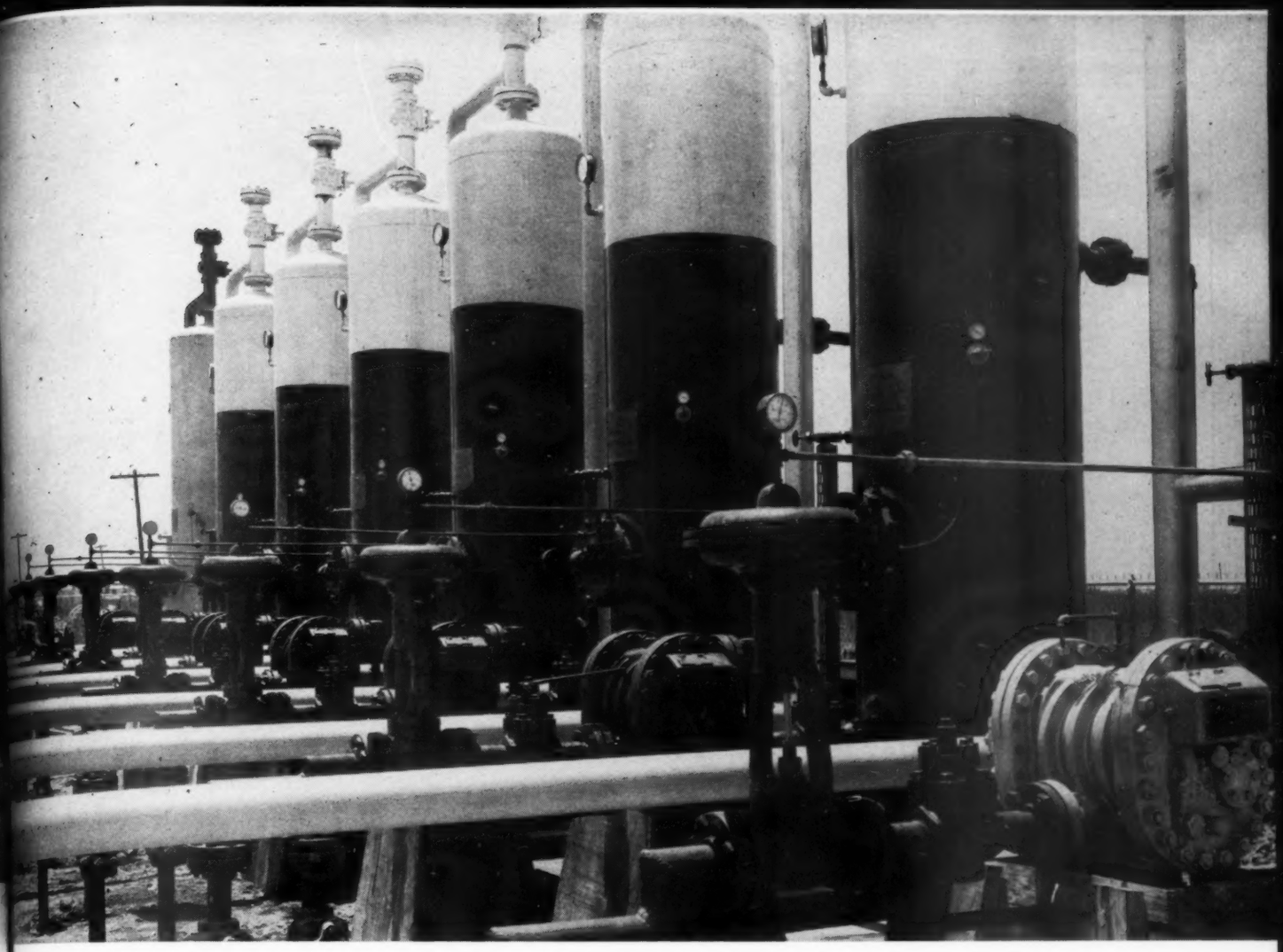


View showing pilot operated oil control on HANLON-WATERS Oil and Gas Separators with BASSLER LIQUID METERS installed on the oil outlet from each separator. These meters measure the production of oil from each lease, eliminating the necessity for erection of gauging and storage tanks on the lease.

The completeness with which this new plant is equipped with HANLON-WATERS Oil and Gas Separators, Bassler Liquid Meters and Automatic Liquid Level and Pressure Control Equipment is another significant indorsement of their high quality and satisfactory performance.

WATERS INC.

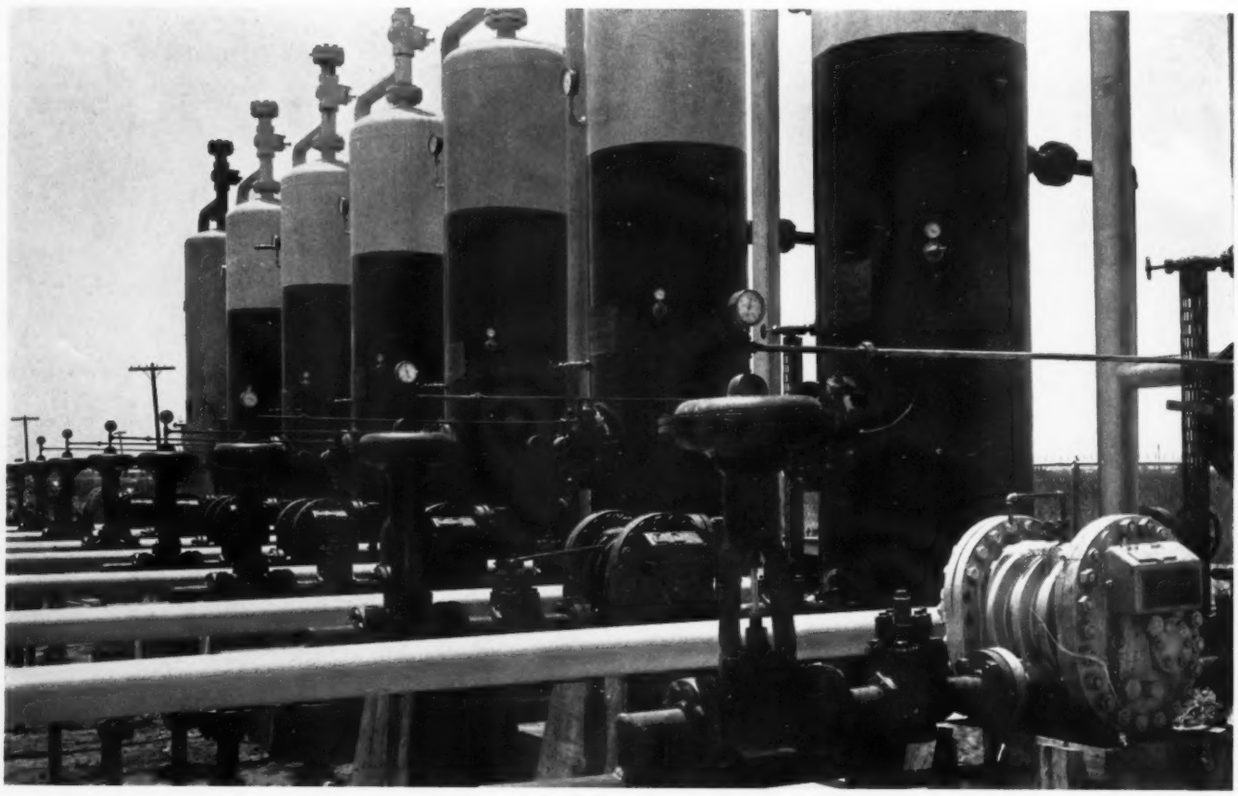
LDG., TULSA, OKLAHOMA

CORPUS CHRISTI WINK PAMPA, TEXAS

REVEPORT, LOUISIANA HOBBS, NEW MEXICO

BASSLER *LIQUID METERS*

ARE SAVING MONEY AT TEPETATE



The Bassler Thermostatic Liquid Meter is a positive piston displacement meter which automatically compensates for temperature changes of all liquids measured. It registers as of 60 degrees Fahrenheit, in units of barrels or gallons. Its accuracy is well within all tolerances promulgated by State and Federal Weights and Measures Departments, and this accuracy is constantly maintained, regardless of changes in rates of flows; changes in line pressures, or viscosities.

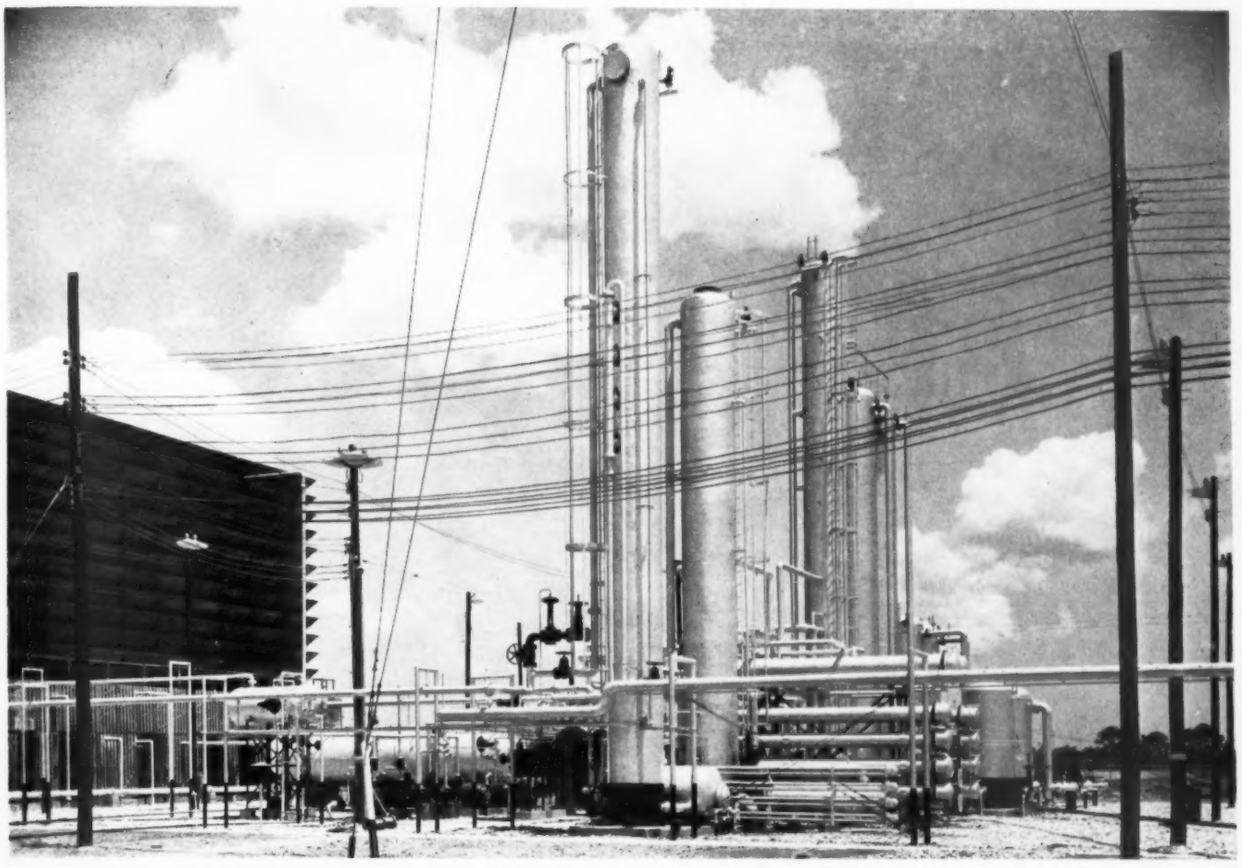
Bassler Meters are manufactured in all sizes and for all working pressures. They will not operate on reversal of flows, nor can they be tampered with without detection. All Bassler Meters can be supplied with proportional samplers which furnish at all times an accurate representative sampler of the fluid measured.

Installed directly on the flow line leading from separators to plant, Bassler *temperature compensating* Liquid Meters on this unusual plant of the Continental Oil Company in the Tepetate Field, accurately measure the flow of crude without gauging tanks. This is the only type installation that would permit efficient stabilization of the crude without waste of the more volatile gases.

DISTRIBUTED IN THE MID-CONTINENT BY
HANLON-WATERS, INC.

The AMERICAN LIQUID METER COMPANY

ALHAMBRA, CALIFORNIA



Crude oil stabilizing and gasoline recovery equipment. Towers and all steam lines are thoroughly insulated

Crude Oil Stabilization and Gasoline Recovery Plant of Continental Oil Co. at Basile, La.

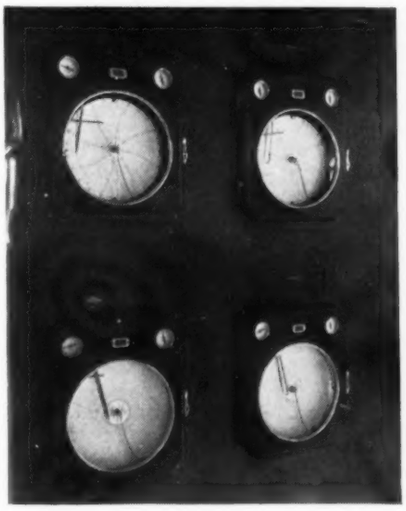
By E. O. BENNETT*

Stabilizing Crude at the Well and Recovering Light Ends from the Crude and Heavy Vapors from the Gas Is Efficiently Accomplished in Modern Plant . . . An Innovation in Modern Oil Production Practice

CRUDE oil produced from deep wells under high pressure usually carries large volumes of dissolved gases. When produced by ordinary production methods the crude suffers a loss by evaporation due to a large reduction of pressure and usually a certain amount of weathering, before delivery to the pipe line. Further losses are incurred in transportation. By the time the crude reaches the refinery the loss is likely to be quite large.

An effective way to reduce or obviate this loss is to stabilize the crude at the well. Stabilization of the crude involves the removal of all the gas in solution and the wild or volatile fractions of the crude; gasoline and other rich vapors are recovered from the gas. To do this efficiently requires a crude stabilization and gasoline recovery plant of special design right in the field. Such a plant has recently been put into operation in the Tepetate field at Basile, Louisiana, by the Continental Oil Company.

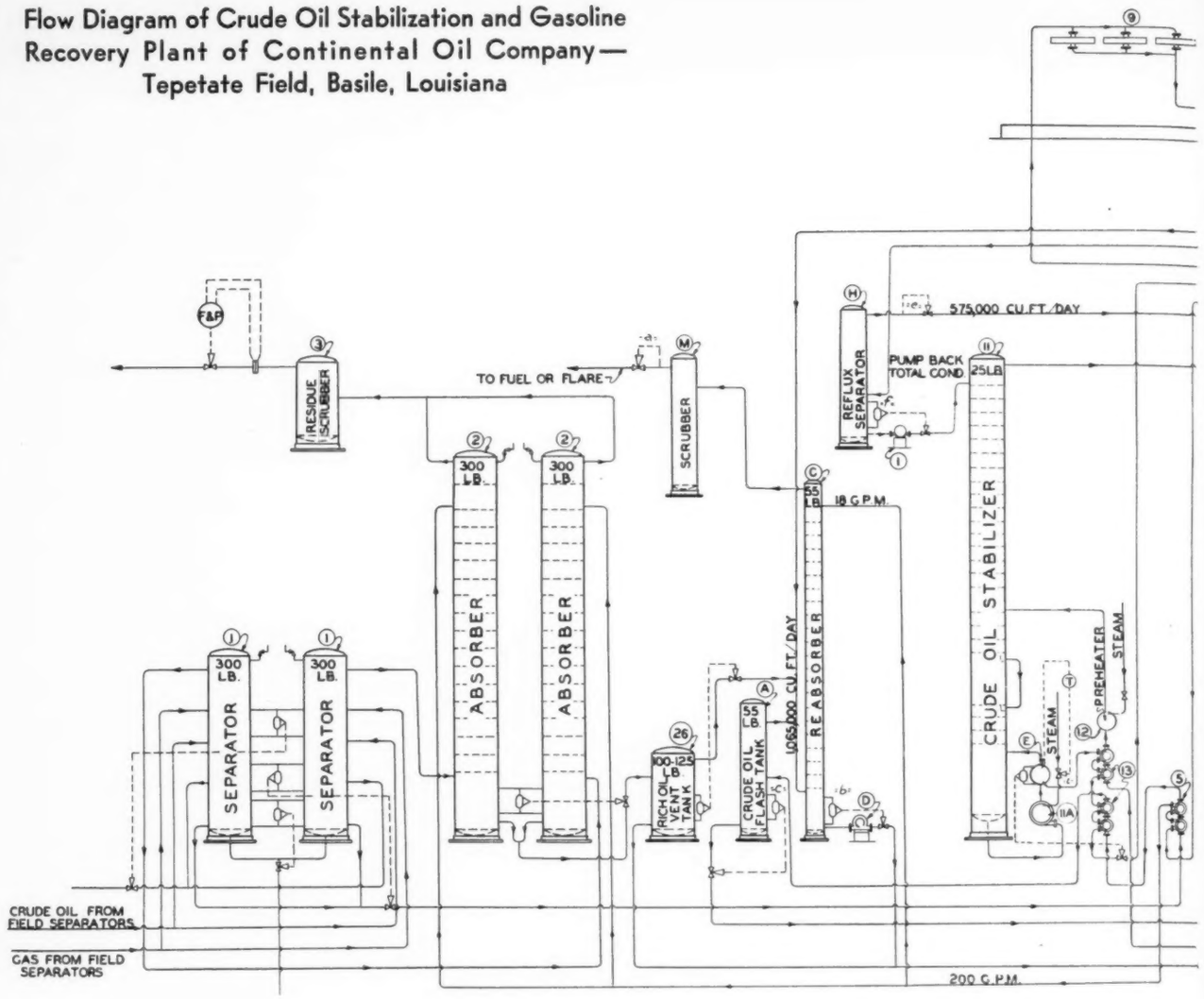
This plant is unique among gasoline plants in the departures from the conventional methods employed in the



Plant operator's control board, on which temperature, pressure, and flow recorders are mounted

*Chief Petroleum Engineer, Continental Oil Company, Ponca City, Okla.

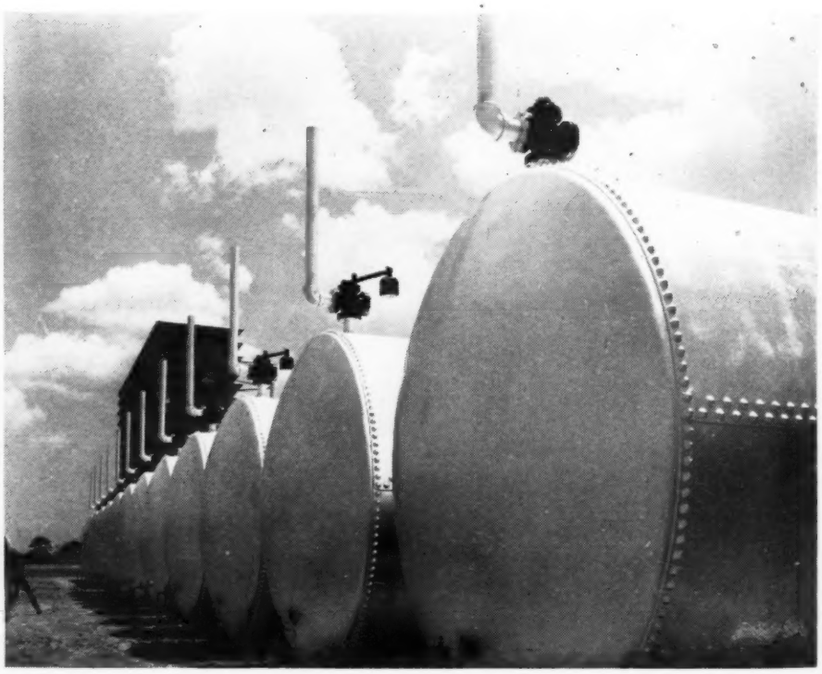
Flow Diagram of Crude Oil Stabilization and Gasoline Recovery Plant of Continental Oil Company— Tepetate Field, Basile, Louisiana



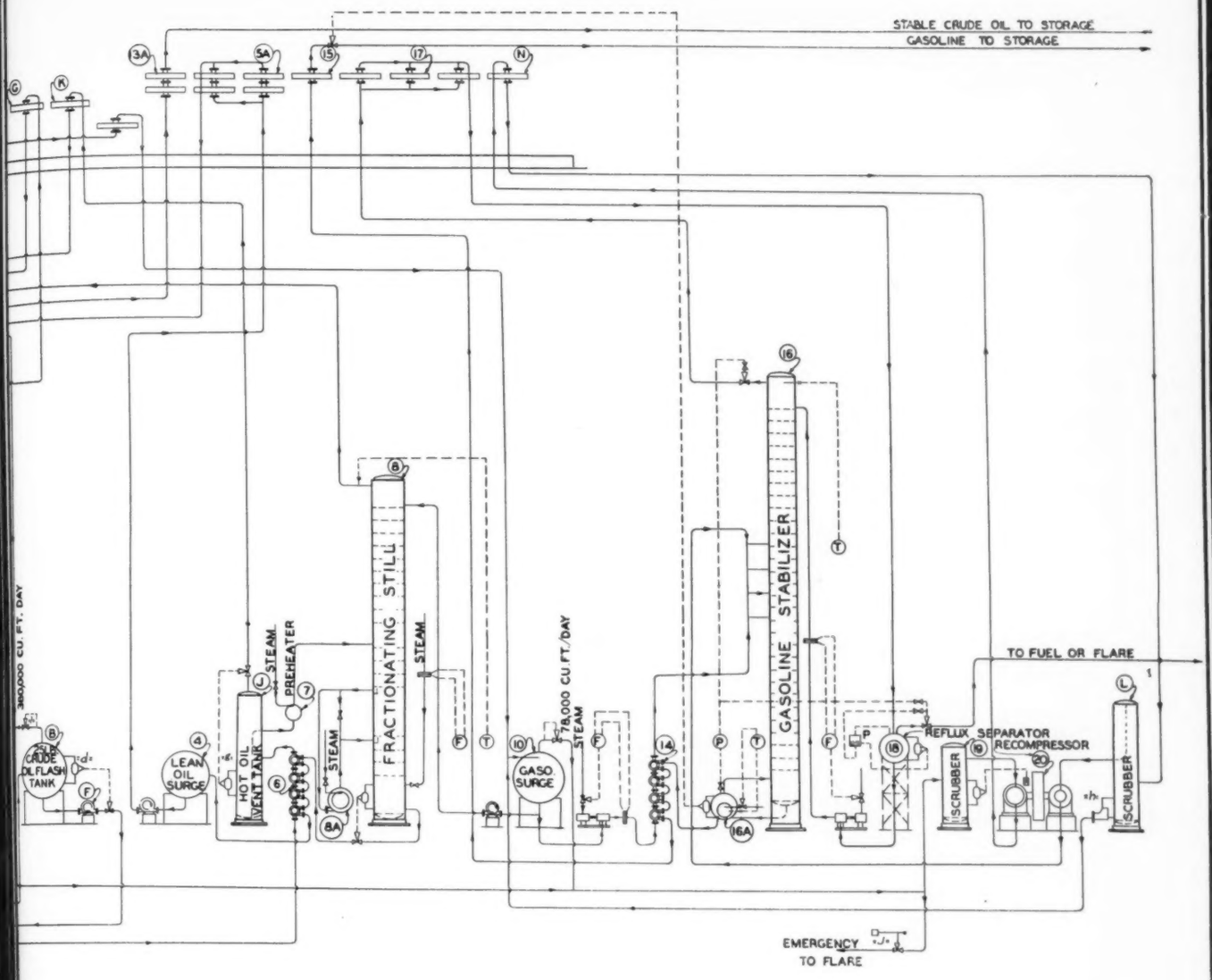
gathering of gas, and in the inclusion of equipment to stabilize the crude oil from all the wells connected to the plant in order to recover the gasoline and lighter ends that, when the usual production methods are followed, is lost in pressure reductions, weathering, and transportation.

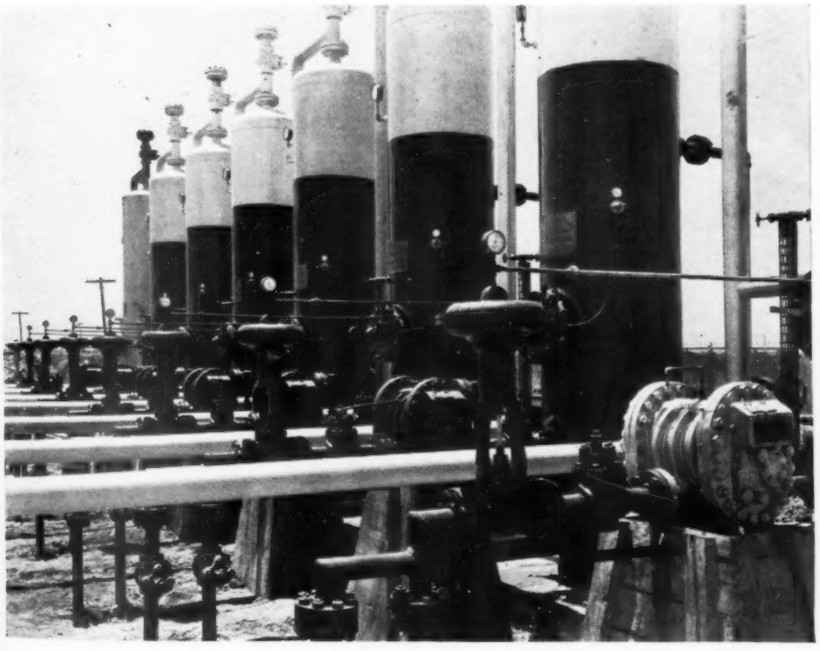
Gathering System, Field Separators, and Meters

Original ideas have been followed in laying out the gathering system. All the field separators have been installed in a battery in the plant yard. Instead



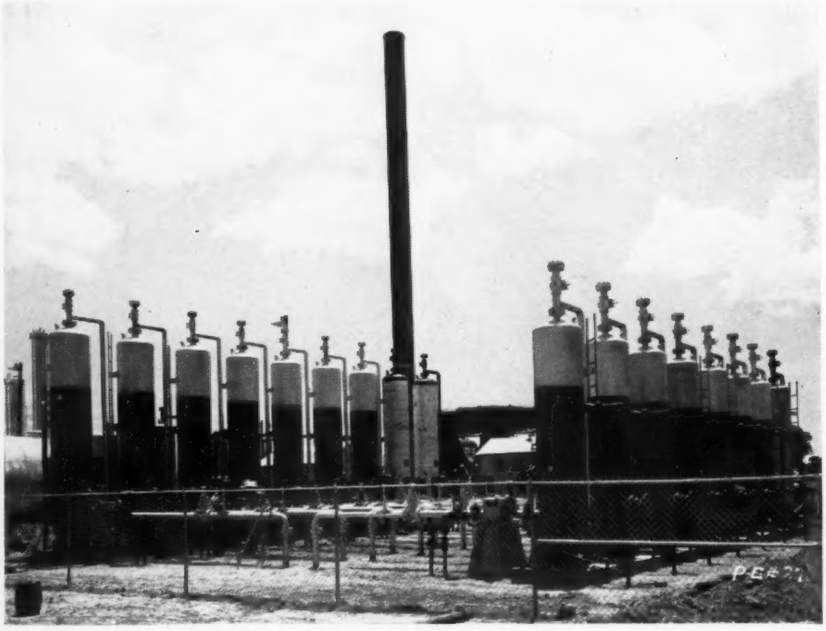
Gasoline rundown tanks. Since picture was taken all vent lines from relief valves have been manifolded and carried to residue discharge line for safety





of each well having a separator there is only one separator to each lease. Most of the leases, some 16 of which are now producing, have but one well at present. The gathering system consists of a single line from each of the various leases to the various separators. These lines serve as a combined crude and gas gathering system. On the one-well leases the size of the gathering line is 2-in. and on all other leases 3-in., each well on the lease is connected by a 2-in. flow line to the lease gathering line at the nearest point. The length of the longest gathering line is about 3000 feet.

Liquid meters and pilot-operated pressure controls on oil lines from field separators



The field separators are operated in a battery with a common back-pressure regulator, to maintain the separator pressure, which at present is 340 lb., and single line leading from this back-pressure regulator for delivery of the gas to the absorption plant. Each separator is equipped with a recording orifice gas meter and a positive displacement type oil meter operating at separator pressure.

Crude Stabilization Process

After measurement, the crude from the various separators is combined into a common stream. Both the gas and crude oil from the field separators are admitted to the plant separators (1).[1] The plant separators are operated at present at a pressure of 300 lb., or 40 to 50 lb. below that of the field separators. The purpose of admitting the crude to these separators is to combine the gas liberated from the crude by the reduction in pressure with the gas directly obtained from the field separators, for processing in the absorption plant. The plant separators (1) are equipped with liquid-level controllers at three different elevations. The lower controller is for releasing any water that may settle in the separator. The middle controller operates the valve, releasing the crude oil to the crude stabilizer unit. This controller normally maintains the level in the separators.

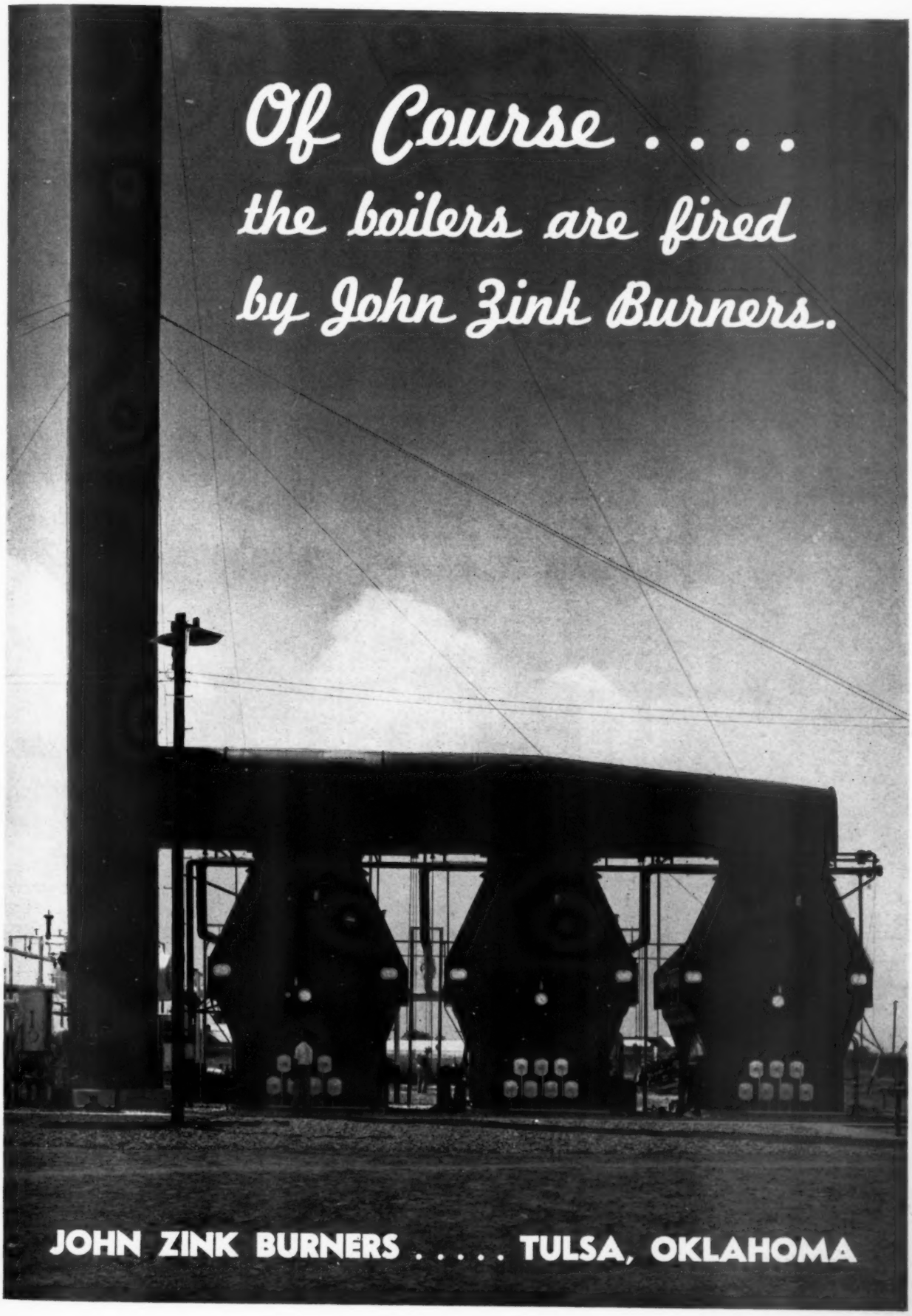
[1]Numbers or letters in parenthesis refer to the various items of plant equipment illustrated on Flow Diagram on pp. 136 and 137.

Top of Page—Orifice meters and fittings on gas lines from field separators.

Center—One of the producing wells. Gauge shows a pressure of 2400 pounds. Part of the plant can be seen in the right background.

Bottom of Page—Battery of field separators at the plant, into which oil and gas is received direct from the well. Each separator has a displacement meter for oil measurement and an orifice meter for gas. Since this picture was taken the safety heads on the separators have been connected by a manifold to a vent line that is led off to a safe distance from the plant.

CONOCO



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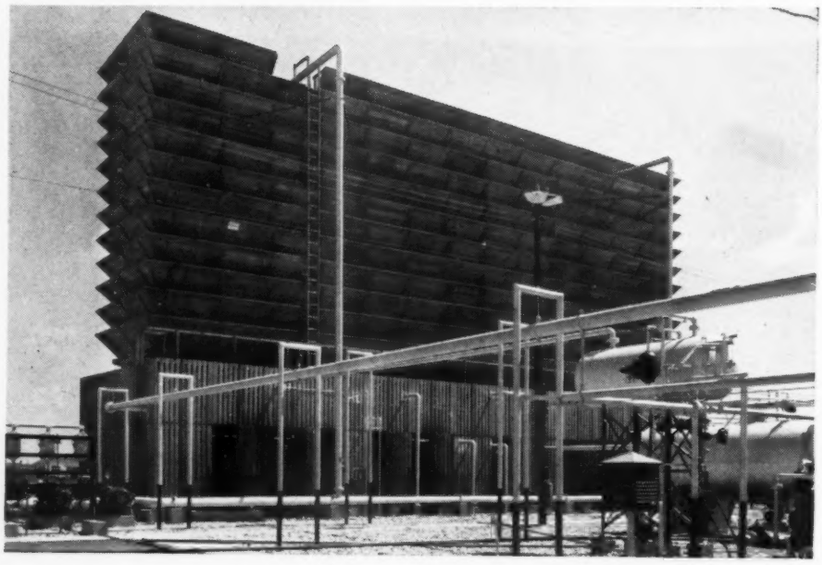


The high-level controller is installed for the purpose of releasing crude directly from these separators to the crude oil storage, in the event that the flow is shut off in the process area. This controller is purely an emergency device.

The pressure of the crude to be processed is further reduced in two stages, the reduction being obtained by passing the crude through heat exchangers (5) and (13), thence to flash tank (A), pressure 50 lb., and thence to flash tank (B), pressure 25 pounds. The vapors from both these stages is treated by the gasoline plant equipment. From the second stage the crude oil is pumped through heat exchangers (13) and preheater (12) to the crude stabilizer unit (11). The operation of this unit is more or less comparable to the operation of a debutanizer. The stabilizer (11) is operated at comparatively low pressures, about 25 lb., and a very light cut taken from the crude. The cut is made merely deep enough to produce a propane-free crude and take over enough condensable material to produce reflux for the column. The crude stabilizer overhead product is treated by the gasoline plant for gasoline recovery. The stable crude is released from the bottom of the tower through the reboiler, heat exchangers (13), and coolers (13A) to the crude oil storage on the lease.

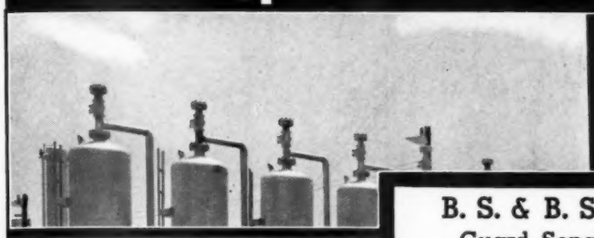
Top of Page—Reciprocating pumps in the foreground. Lean oil and reflux pumps in the right background electric-driven by explosion-proof motors. All pumps are equipped with automatic regulating and control devices.

Center—Cooling tower, within which are housed atmospheric sections for cooling and condensing. Small square house in right foreground houses the weather instruments.

Bottom of Page—The residue gas lines from the plant. Note pressure control equipment on valve in right foreground.

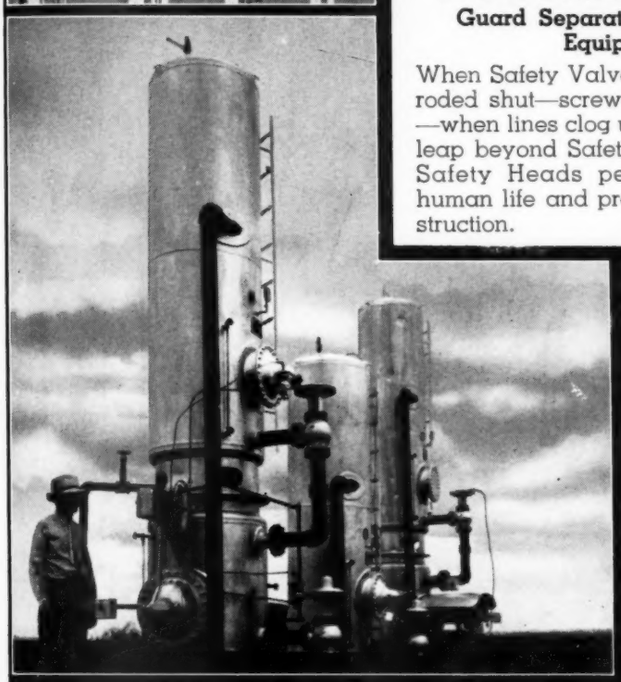
CONOCO

Continental Employs B.S.&B. Safety in Big Basile Stabilization Plant



B. S. & B. SAFETY HEADS
Guard Separators and Other Equipment

When Safety Valves too small—corroded shut—screwed down too tight—when lines clog up—and pressures leap beyond Safety point, B. S. & B. Safety Heads perform to protect human life and prevent property destruction.



B. S. & B. Meter Test in Ward County, Texas

FOR FUTURE STABILIZATION PLANTS
B. S. & B. METER SEPARATORS

Investigate the revoluntionary, new, B. S. & B. Meter Separators and Metering Chambers. Meter chamber, integral with separator or as separate unit; Mechanism adjustable to allow for evaporation losses between meter and separator and stock tanks. Permits continuous sampling; won't get gas bound; has no close fitting wearing parts.

B. S. & B. FURNISHED HIGH QUALITY FLEXWELDED PRESSURE VESSELS

B. S. & B. Equipment for the Continental Basile Plant includes:
2 60" x 42' Absorbers
2 60" x 18' Separator Tanks
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173,000 lbs. of X-Rayed, Flexwelded 1⅜" High Quality Pressure Vessels

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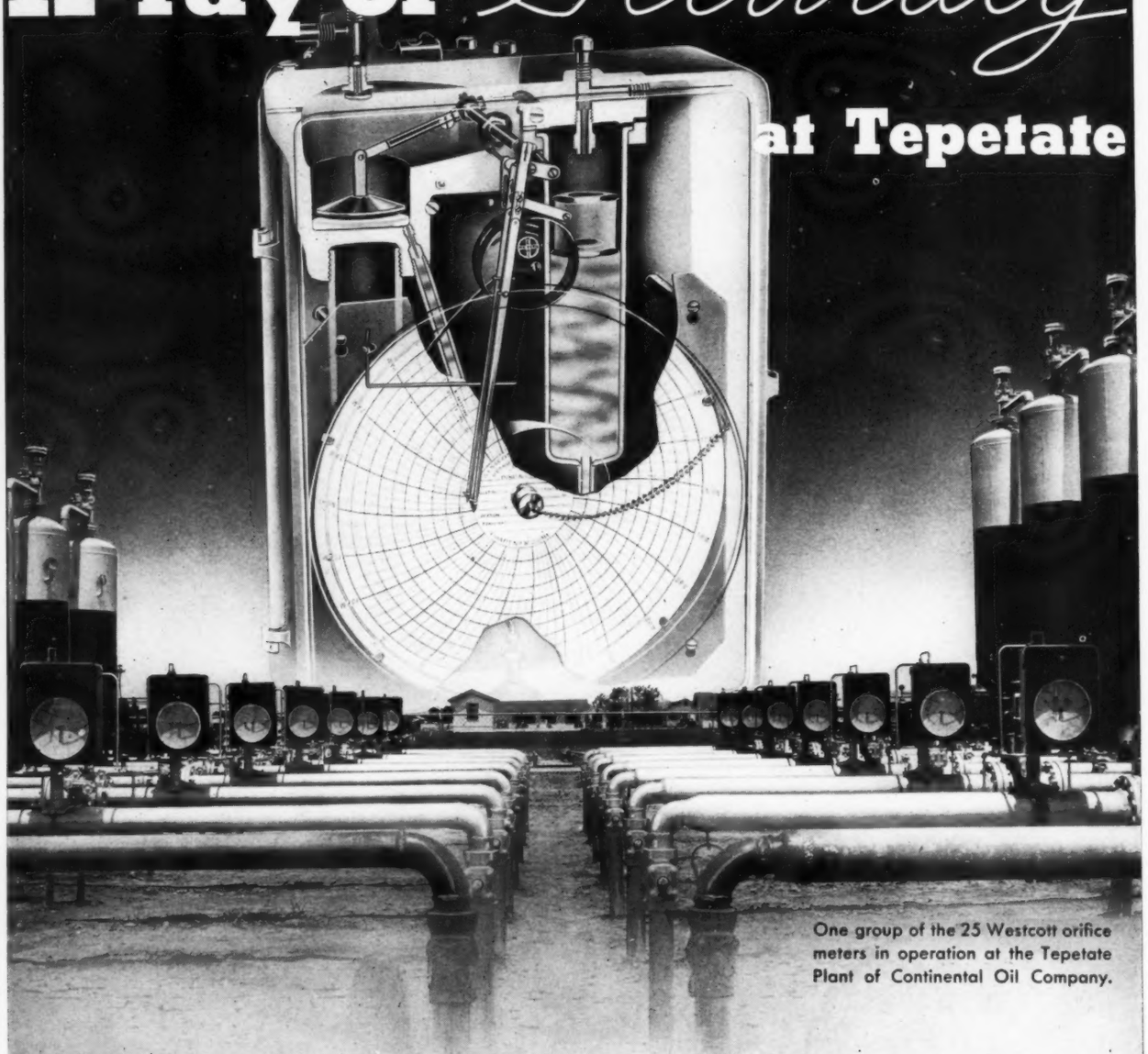
X-ray of *Accuracy* at Tepetate



One group of the 25 Westcott orifice meters in operation at the Tepetate Plant of Continental Oil Company.

EXAMINE WHAT IT IS that makes Westcott orifice meters appeal to the man out in the field . . . the meter engineer who sees the difference between instruments in terms of the number of adjustments and the maintenance necessary to **KEEP** them accurate!

Notice the **SIMPLICITY** of Westcott meters . . . There's only one moving part between the surface of the mercury and the chart record.

Note too the large float area, with wide clearances eliminating loss of accuracy due to dirt collecting on the mercury . . . the low angle of travel of the float . . . and the small angular travel of the static tube. They make the Westcott meter a **PRACTICAL** instrument, insuring not only accuracy but ruggedness.

New and complete data will be mailed on request. Also, information on new popular Round Case Indicating Flowmeter.

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AMERICAN METER COMPANY
INCORPORATED
Measurement and control of Gas, Oil, Steam, Air and Liquids
METRIC METAL WORKS *ERIE, PENNSYLVANIA*

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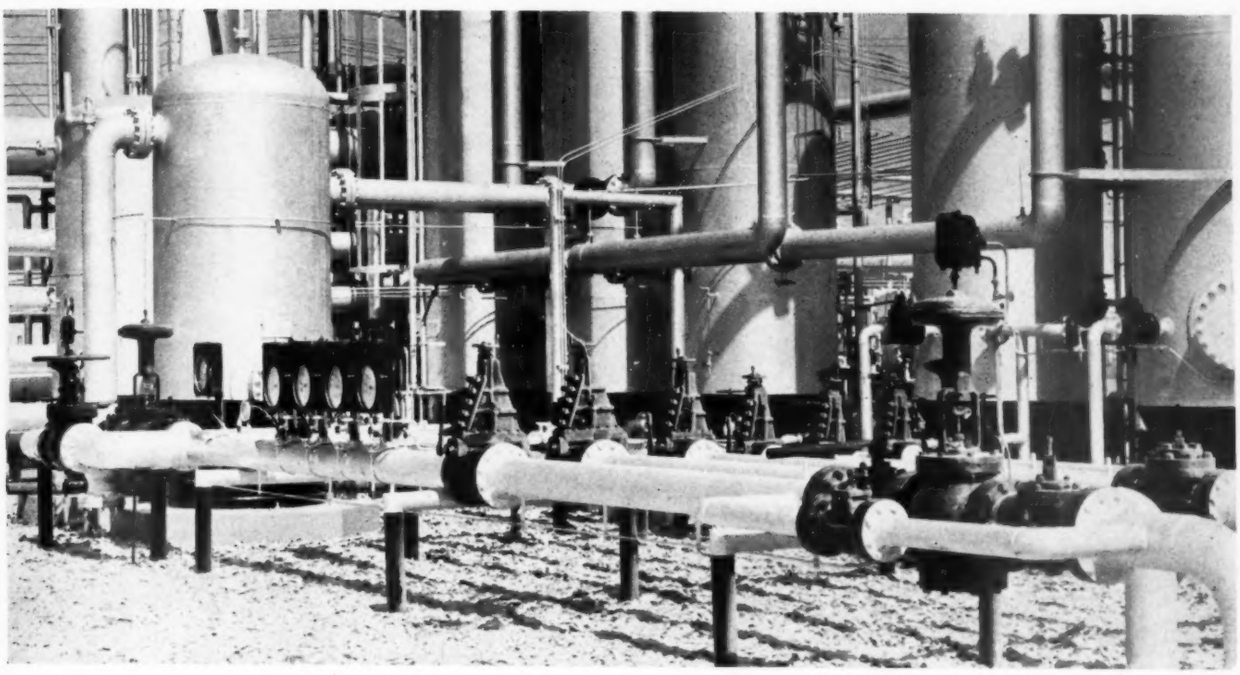
CONTINENTAL OIL COMPANY'S

TEPETATE PLANT, BASILE, LA.



A FEW of the many WESTCOTT ORIFICE METERS and ROBINSON Type "E" ORIFICE FITTINGS used in the Industry's most modern Gasoline Recovery and Crude Oil Stabilization Plant.

For Simplicity, Ruggedness and Complete Reliability in measurement Westcott Meters and Robinson Type "E" Orifice Fittings always have been accepted as the "standard"—recent improvements provide a new standard of convenience and safety for the needs of today, and of tomorrow!

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From designs by Petroleum Engineering, Inc. Associated with Arthur G. McKee & Company.

FABRICATED IN DALLAS SHOPS of

WYATT METAL & BOILER WORKS

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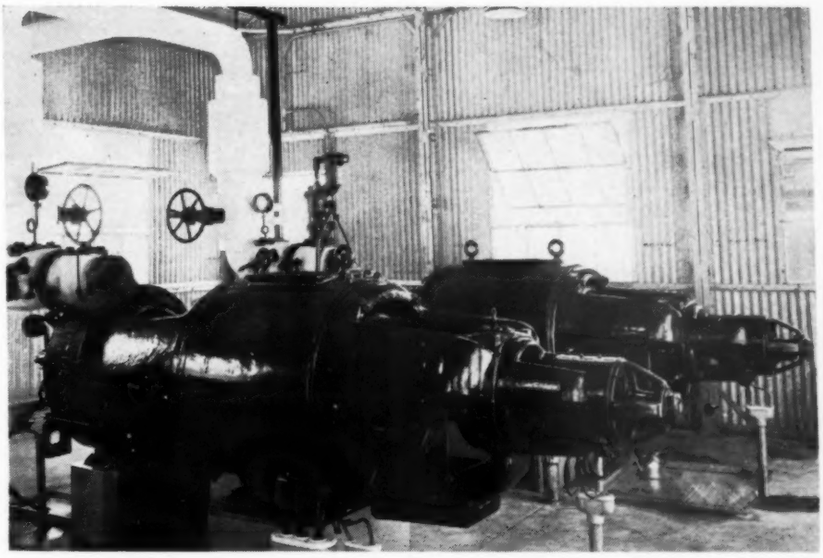
Absorption System

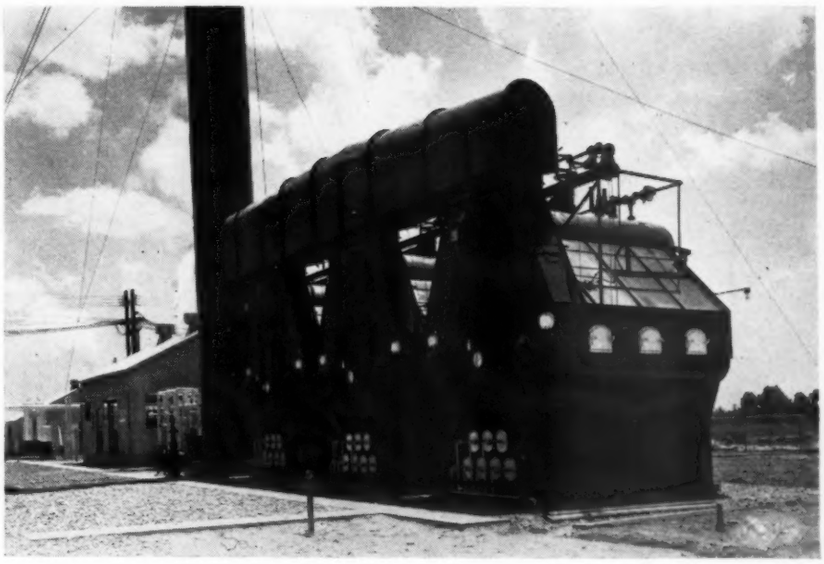
The absorption system is more or less conventional except for two variations from the usual practice. The first of these is the method of subcooling the lean absorption oil below the temperature obtainable by water-cooling, by heat exchange with the cool crude oil released from the separators (1). This subcooling takes place in the exchanger (5).

The second departure from the usual practice is in the method of handling plant vapors. Vapors flashed from the crude in the first stage from tank (A), vapors flashed from the rich oil in the first stage from tank (26), and vapors flashed from the rich oil in the second stage from tank (J), are treated by the reabsorber (C) for their gasoline recovery. These vapors are available at a pressure of 50 lb. or greater and are comparatively lean for plant vapors.

Vapors flashed from the crude oil in the second stage from tank (B), vapors removed from the crude oil by the stabilizer from reflux separator (H), and vapors from the gasoline distillation unit surge tank (10), are handled by the recompressor unit (20). These vapors are comparatively rich in butane and heavier gasoline fractions. The recompressor unit (20), operating in two stages, delivers these vapors directly to the gasoline stabilizer (16) for recovery.

Gasoline from the surge tank (10), which consists of the raw product absorbed in the main absorber, the raw





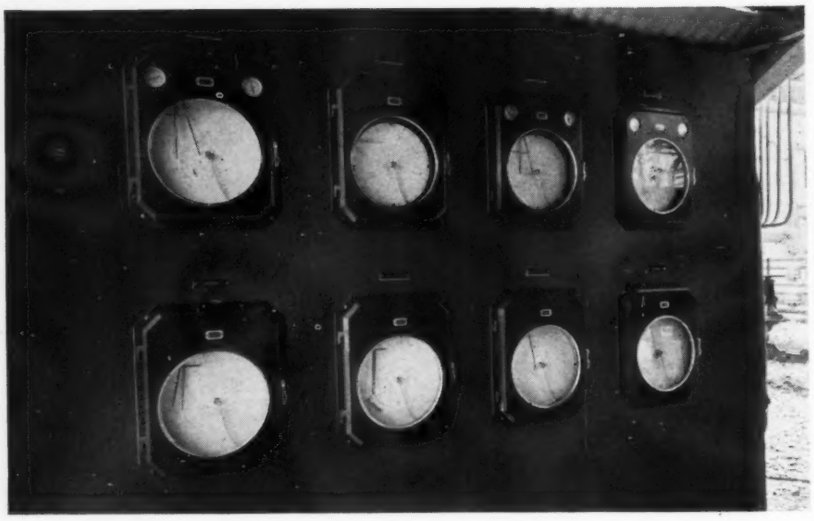
Top of Page—Two turbo-driven generators of 550-kw. capacity for a-c. power supply. Steam from turbine is also used for process operations in the plant.

Center—Control panel and synchronizing device in power plant.

Bottom of Page — Outdoor type 256-hp. water tube boilers for steam supply to process and power plants. Residue gas is used in boiler burners.

FOR TEMPERATURE, PRESSURE AND FLOW

—at Tepetate



CONTINENTAL OIL COMPANY

relies on Taylor Instruments for accurate recording and controlling

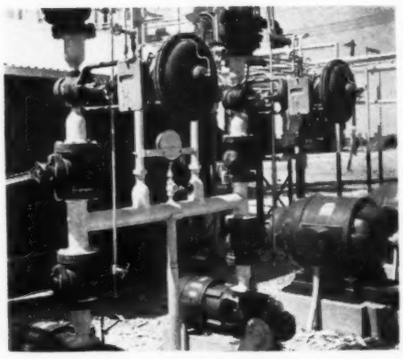
WHEN new methods of refining are evolved, new problems of temperature, pressure and flow control arise which can be met only by engineers of skill and experience.

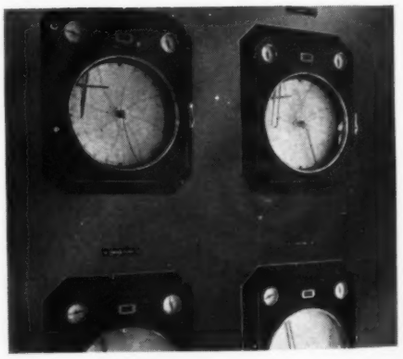
Petroleum Engineering, Inc., in designing and erecting the Tepetate Crude Stabilization and Natural Gasoline Plant for The Continental Oil Co., at Basile, La., met such problems successfully with the aid of Taylor Engineers.

By a unique combination of Taylor recording and controlling instruments it is possible in this plant to see a record on one chart of back pressure control of the absorber as well as a record of the gas flow vented from the absorber.

This is one example of the way Taylor Engineers working with Petroleum Engineering, Inc., met today's needs for simplified, exact control in modern refining. It was developed out of Taylor experience with refining problems and with the adaptability of Taylor Recording and Controlling Instruments. See the list of Taylor products used in this new Tepetate refinery.

If you have any old or new questions concerning temperature, pressure, level or rate of flow, a Taylor Representative with the aid of Taylor Engineers is at your service. Address Taylor Instrument Companies, Rochester, N. Y., Tulsa, Okla., or Toronto, Canada.





THESE TAYLOR INSTRUMENTS DO THE JOB AT TEPETATE

1—Fulscope combination recording pressure controller and flow meter for ABSORBER BACK PRESSURE CONTROL AND FLOW METER.
2—Recording flow meters to measure LEAN OIL.
1—Fulscope recording flow controller and Valv-Precisor for STABILIZER REFLUX FLOW CONTROL.
1—Fulscope recording temperature controller with Valv-Precisor for STILL TOP TEMPERATURE CONTROL.
1—Fulscope recording temperature controller with Valv-Precisor for CRUDE STABILIZER TOP TEMPERATURE CONTROL.
1—Fulscope recording temperature controller with Dubl-Response Control Unit for STABILIZER REBOILER TEMPERATURE CONTROL.
1—Fulscope recording pressure controller for STABILIZER BACK PRESSURE CONTROL.
1—Recording thermometer for STABILIZER TOP TEMPERATURE.
2—Recording flow meters with Static pressure elements for RICH GAS.
2—Dial Type rate of flow indicators for Steam.

Taylor

Indicating / Recording Controlling

TEMPERATURE, PRESSURE *and* **FLOW INSTRUMENTS**

Water circulating pumps, electric-driven by explosion-proof motors

product absorbed from the crude oil flash, and other vapors in the reabsorber (C), and gasoline from the recompressor interstage scrubber (L), is pumped through heat exchangers (14) to the gasoline stabilizer unit (16).

The gasoline stabilizer feed consists of the combined liquid stream from the surge tank (10) and vapor stream from the recompressor (20). The gasoline stabilizer functions both as a stabilizer unit to remove undesirable light fractions from the liquid feed and as a recovery unit to remove gasoline fractions from the vapor feed. Except for the combined liquid and vapor feed, the gasoline stabilizer is conventional in its operation. The bottom product consists of gasoline of any desired commercial vapor pressure, and the overhead product of excess butane and lighter vapors, which are delivered to the fuel system.

Only a small portion of the product of this plant, when operating as outlined, is recovered from the crude oil, the major portion being recovered directly from the gas. The crude stabilizing operation results in saving the gasoline fractions usually lost in weathering and transportation. In addition to this saving, some gasoline is recovered from the flashed vapors and crude stabilizer overhead product.

TABLE I
Composition of Charged Material and Products

BASIS: Crude oil and gas equilibrium at 250 lb.
Operation for Propane-free Crude and 26-lb. V.P. Natural Gasoline

	CHARGE		PRODUCTS	
	Crude Liq. Vol. %	Gas Mol. %	Crude Liq. Vol. %	Gasoline Liq. Vol. %
Methane	2.60	88.72		
Ethane	1.23	5.44		
Propane	2.77	3.22		
Butanes	3.66	1.60	0.98	26.75
Pentanes	3.92	.69	3.02	48.82
Hexanes and Heavier	85.82	.33	96.00	24.43
	100.00	100.00	100.00	100.00

Plant Utilities and Auxiliary Equipment

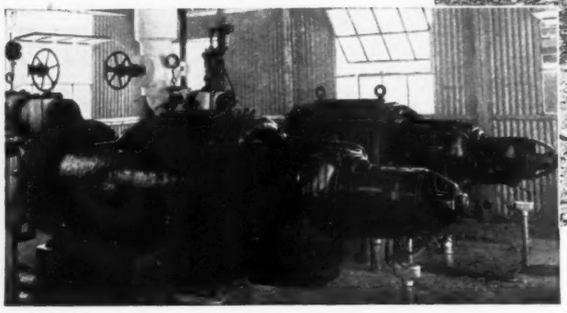
The plant is modern in the usage of the latest types of metering, control, and process equipment. Outdoor type electric-driven pumps are employed for oil circulation, still and crude stabilizer reflux pumping, water circulation, and

Reading from right to left: Boiler feed pumps, power plant building, recompressor building, and water well building

Where dependability counts—

CONTINENTAL CHOOSES GENERAL ELECTRIC DRIVES FOR NEW BASILE PLANT

Three efficient workmen on duty—G-E 30-hp explosion-proof motors driving circulating-water pumps in new Basile plant



Above—*General Electric explosion-proof motors driving lean-oil and reflux pumps in new Continental plant*

Left—*Two G-E turbines drive generators for power supply in addition to supplying process steam for crude stabilization and gasoline recovery operations*

THEY'RE checked and double checked, tested and retested — these G-E explosion-proof motors—for they're built to give DEPENDABLE SERVICE, such as the Continental Oil Company must have from the motors in its new Basile, Louisiana, gasoline recovery and stabilization plant.

Every test to which a General Electric motor is subjected before being approved for use is designed to assure us that the motor more than meets the strictest requirements. When used with G-E control (all control for this new plant is G-E oil-immersed) it makes a combination which will give long, safe, and uninterrupted service.

In addition to supplying all motors and control, General Electric assisted Continental in making this plant one of the finest, most modern in the Louisiana field by furnishing all conduit, wire, cable, and lighting units and equipment.

You, too, can come to General Electric, with full confidence, for all kinds of electric apparatus for stabilization plants. See the oil specialist in the nearest G-E office. General Electric, Schenectady, N. Y.

020-303

GENERAL ELECTRIC

TABLE 2

Typical Plant Operating Conditions

Crude Oil Stabilizer	
Charge	3802.5 bbl./24 hr. (Measured at Field Separators)
Stable crude	3390.0 bbl./24 hr. (Measured to Storage)
Tops	412.5 bbl.
Estimated	69.2 bbl. (2905 gal.) Gasoline in Tops
Net	343.3 bbl. Stab. Loss 9% Excess Butane and Lighter
Operating pressure	25 lb. gauge
Bottom temperature	260 deg. fahr.
Top temperature	120 deg. fahr.
Reflux rate	465 g.p.h.
Absorbers	
Gas volume main absorber	28,356,000 cu. ft./24 hr.
Gas volume reabsorber	605,000 cu. ft./24 hr.
Oil circulation main absorbers	140 g.p.m.
Oil circulation reabsorber	15 g.p.m.
Absorption oil/gas ratio	7.1 gal./1000 cu. ft.
Main absorber pressure	250 lb. gauge
Reabsorber pressure	50 lb. gauge
Lean oil temperature	68 deg. fahr.
Main absorber bottom temp.	71 deg. fahr.
Gasoline Still	
Process steam	935 lb./hr.
Process steam/oil ratio	0.107 lb./gal.
Pressure	50 lb. gauge
Feed temperature	351 deg. fahr.
Bottom temperature	343 deg. fahr.
Top temperature	204 deg. fahr.
GASOLINE STABILIZER:	
Charge: Recompressed vapors	642,500 cu. ft./24 hr.
Raw gasoline	15,130 gal./24 hr.
Product: 16,035 gal./24 hr. total	
Estimated 2,905 gal./24 hr. from crude stabilizing	
Net: 13,130 gal./24 hr. from gas	
Net yield: 0.463 gal./1000 cu. ft. gas	
Reflux	24 g.p.m.
Pressure	275 lb. gauge
Reboiler outlet temperature	295 deg. fahr.
Column top temperature	146 deg. fahr.
Column feed temperature	235 deg. fahr. (liquid)
Column feed temperature	180 deg. fahr. (vapor)
Reid V.P. of product	25.3 lb.
UTILITIES:	
Steam at 150 lb.	
Crude stabilizer heat	2400 lb./hr.
Gasoline still heat	3600 lb./hr.
Gasoline still process	935 lb./hr.
Gasoline stabilizer heat	1260 lb./hr.
Gasoline stabilizer pumps	250 lb./hr.
Total three 256-hp. boilers	8445
Cooling Water	
Main cooling tower	2400 g.p.m.
Recompressor cooling tower	300 g.p.m.
Electrical Current	
Water pumps	60.0 kw.
Lean oil pumps	45.0 kw.
Reabsorbers R.O. pumps	2.7 kw.
Reflux pumps	1.3 kw.
	109.0 kw.

for pumping well water. Explosion-proof electric motors are employed throughout. Two turbo-generators of 550 kw. capacity, generating a-c. current, comprise the power plant, which is an integral part of the installation and is used to supply electric current for pumping equipment, air compressors, the laboratory, plant lighting, company's field camp nearby, and the company's oil pipe line pump in the plant. Three outdoor type 257-hp. water tube boilers are used to supply steam for the plant process and steam turbines of the power plant. Residue gas is used as fuel in the boiler burners. All cooling and condensing equipment is in the form of atmospheric sections installed in the cooling tower.

All the finished gasoline is pumped through a pipe line to a loading rack approximately six miles distant from the plant. The stabilized crude is pumped through a 6-in. pipe line to the company's terminal at Lake Charles, Louisiana, a distance of about 45 miles.

Residue gas from the plant is transported by 8-in. pipe line direct to market outlets at Lake Charles, Louisiana; fuel requirements at the four drilling rigs in the field are also supplied from the residue gas system. All the rest of the residue gas available eventually will be returned to the sand. A pressure maintenance program for the field is now being worked out, whereby it is hoped to maintain a high reservoir pressure and thus prolong the flowing life of the wells. It is estimated that injection pressures as high as 4000 lb. may be required to return the gas to the sand in sufficient volume.

Operating Data

A list of the analyses indicative of the usual plant operation is given in Table 1.

It should be noted that the data in Table 2 on typical plant operating conditions are from a preliminary run on the plant operating at approximately 60 percent of its designed capacity. Attention is drawn also to the fact that the plant load has been increased since these data were obtained.

Innovation in Oil Production Practice

Although the Tepetate field is almost completely delimited it still is in the active stage of development. Four drilling rigs are kept in continuous operation and wells are completed to a depth of 8300 ft. at the average rate of about four a month. Formations are relatively easy to drill and 3-way drag type bits are used almost entirely.

The entire productive acreage in the field is on leases held by the Continental Oil Company. This was one of the favorable factors governing the decision to erect the stabilization plant in the field. Being the only operator in the field the company can lay out a uniform and adequate program of efficient development and production methods that will result in the greatest ultimate recovery of oil at a low lifting cost per barrel.

Crude is produced from an average depth of 8300 ft. and as might be expected the reservoir pressure is high and the volume of gas accompanying the oil large. The discovery well had an initial pressure of 3100 lb. at the casinghead. Tests made on wells in June of this year showed that the bottom-hole static pressure at 8300 ft. is about 3400 pounds. Tubing pressures vary widely in the field and range from 2650 lb. to 900 lb. on different wells. Casing pressures range from 2850 lb. to 1000 pounds.

One of the interesting innovations in this project is the placing of the oil and gas separators at a convenient point in the plant rather than near the wells and the use of liquid meters to measure the oil production. Automatic pressure controls regulate the pressure of the oil passing through the meter so that there is no trouble from gas in solution interfering with the measurement of the oil. Provisions are made for testing the meters with dead oil and live oil and all meters are tested at regular intervals. In addition there is a gas proving meter for testing the orifice meters.

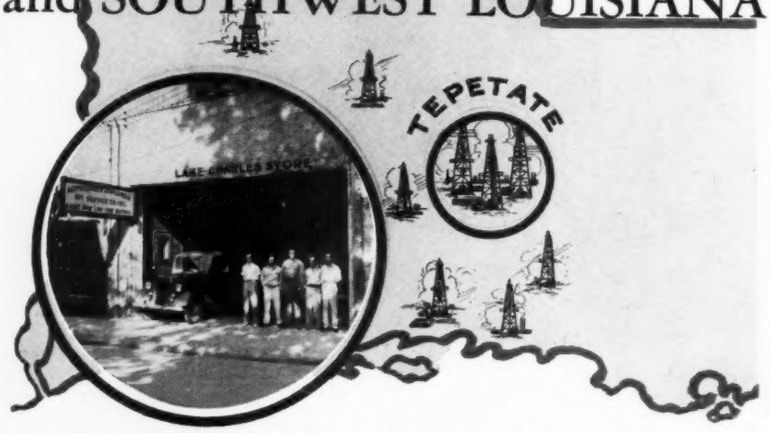
Boiler feed water is automatically and accurately controlled by regulators according to the furnace and load requirements.

Among the advantages of stabilizing the crude are the removal of troublesome impurities and wasteful fractions in the crude. Evaporation is reduced to the minimum and the refiner pays for and receives the crude that is most profitable to him. Advantages also accrue to the pipe line company. Evaporation shrinkage is obviated as also is the accumulation of tank bottoms and the cost of their recovery or removal. The producer markets all his production in definite measurable form—in this case oil, gasoline, and residue gas. Of the economic soundness of this practice there is no doubt.

The plant was designed and constructed according to specifications of the Continental Oil Company by Petroleum Engineering, Inc., associated with Arthur G. McKee and Company.

Producing operations in the Tepetate field are under the supervision of J. G. Dyer, manager of production, Continental Oil Company. O. V. Fisher, production superintendent of

BIT
and WIRE LINE CORE BARREL
HEADQUARTERS
FOR TEPETATE
and SOUTHWEST LOUISIANA



Our Bit and Coring Service in the Tepetate field is an example of the thorough coverage in all Southwest Louisiana from our Lake Charles Shop . . . Southeast Louisiana from our Houma Shop . . . North Louisiana from our Rodessa Shop . . . and the entire Texas Coastal Belt from our Texas shops listed below:

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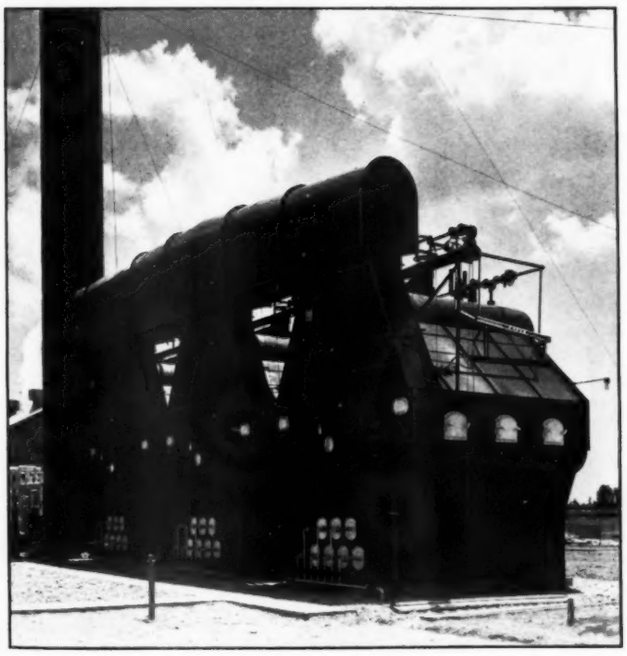

CONTINENTAL selects COPES

Outdoors at Continental's new Tepetate plant, COPES Regulators feed water to the three Wickes boilers exactly as it is needed for the furnace and load conditions. The control is fully-automatic and scientifically accurate.

Years of experience with COPES Feed Water Control had proved to Continental that it was dependable—and a definite aid to safe, economical boiler operation. That is why this — the 11th repeat — order was placed for COPES.

Leaders in the oil and gas industry have made COPES the first choice for boiler feed water control. May we tell you how COPES would benefit you? Write for literature.

NORTHERN EQUIPMENT CO., 3645 GROVE DRIVE, ERIE, PA.

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COPES
SYSTEM OF BOILER FEED CONTROL

BRANCH PLANTS IN CANADA – ENGLAND – FRANCE – GERMANY – AUSTRIA – ITALY – SALES AND SERVICE REPRESENTATIVES IN PRINCIPAL INDUSTRIAL CENTERS THROUGHOUT THE WORLD.

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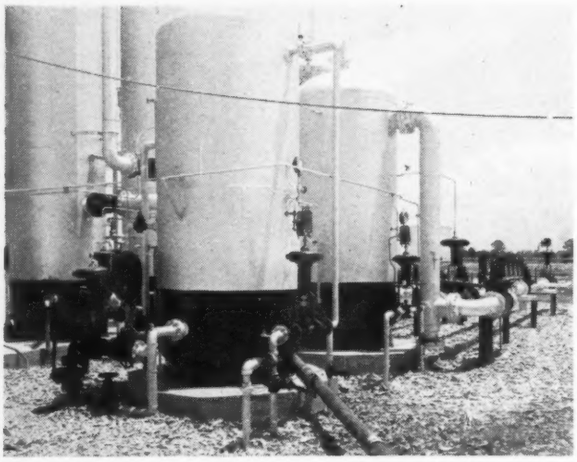

Scrubbers—equipped with automatic liquid-level and pressure controls

the Louisiana district for the Continental Oil Company, is in immediate charge of producing operations. Operation of the plant is under the supervision of R. A. Carter, superintendent of gas and gasoline plants for the Continental Oil Company. F. B. Haverfield is plant superintendent at Tepetate.

Table 3 is a list of major items of equipment in the plant. In addition to the items shown numerous miscellaneous items of equipment such as pipe, tools, and fittings were supplied by Oil Well Supply Company.

TABLE 3

List of Major Items of Plant Equipment, Including Name of Manufacturer

Bassler liquid meters	American Liquid Meter Co.
Westcott orifice meters	American Meter Co.
Safety heads, absorbers, and scrubber tanks	Black, Sivalls and Bryson
Steel buildings	Braden Steel Corp.
Centrifugal pumps (single-stage and 3-stage)	Byron Jackson Co.
Condenser tubes	Chase Brass & Copper Co.
Recompressor unit	Clark Bros. Co.
Steel fence	Continental Fence Co.
Relief valves and towers	Crosby Steam Gage & Valve Co.
Electric switches	Crouse-Hinds Co.
Engine and pump packing	Garlock Packing Co.
Electric motors, generators, and steam turbines	General Electric Co.
Wire cable, conduit, and other miscellaneous electric supplies	General Electric Supply Co.
Fire brick	A. P. Green Fire Brick Co.
Heat exchanger	Griscom-Russell Co.
Oil and gas separators, liquid level and pressure control equipment	Hanlon-Waters, Inc.
Insulation	Johns-Manville Co.
Boiler burners	John Zink Burners
Pipe	National Tube Co.
Copes boiler feed-water regulators	Northern Equipment Co.
Paint	Patterson-Sargent Co.
Relief valves on gasoline storage tanks	Wm. Powell Co.
Cooling tower	J. F. Pritchard & Co.
Bubble caps	Progressive Brass Mfg. Co.
Bubble caps	Refinery Castings Corp.
Orifice fittings	Robinson Orifice Fitting Co.
Pressure, temperature, and flow recording and controlling instruments	Taylor Instrument Companies
Valves and fittings	Walworth Co.
Electric control panel and synchronizing equipment	Westinghouse Electric & Mfg. Co.
Steam boilers	Wickes Boiler Co.
Atmospheric condensers	Worthington Machinery Corp. of Okla.
Reciprocating pumps	Worthington Pump and Machinery Corp.
Bubble towers, reboilers, heat exchangers, scrubbers, accumulators, preheaters, and coolers	Wyatt Metal & Boiler Works

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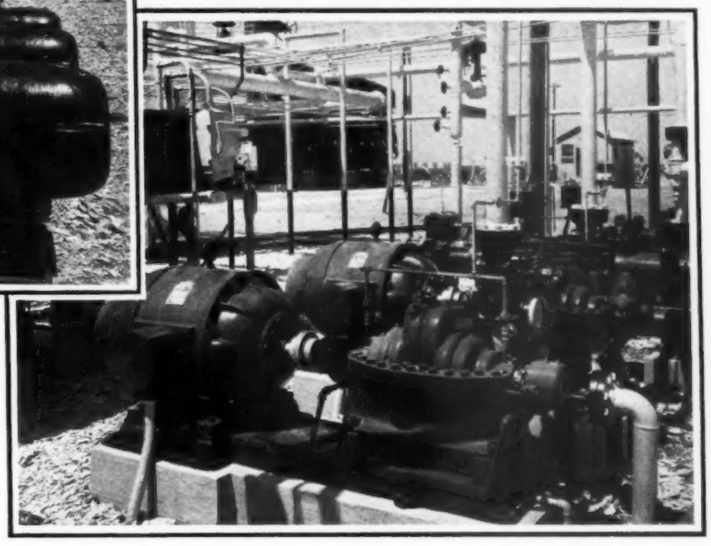

(*Above*)
Byron Jackson single-stage centrifugals.

(*Below*)
Byron Jackson three-stage centrifugals.

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Graphic Method of Analyzing Dynamometer Cards

By J. C. SLONNEGER

Simple, rapid method of analysis by graphic means reveals hidden information on cards and aids in a better understanding of pumping problems

A DYNAMOMETER card of a pumping well is a reasonably accurate record of the mechanical behavior of the entire lifting mechanism. It contains far more information than the mere stress range and the amount of work done. Its shape or contour must bear some relationship to the actual happenings at the plunger in the pump. The information is recorded, and we need only to interpret it.

An attempt is made here to bring out this hidden information. The dynamometer card is a result; the problem is to find the cause. Hence, its solution is an inverse operation, and inverse operations usually are difficult. Furthermore, to be of any practical value, the solution must be simple and rapid and possess sufficient accuracy to permit sound conclusions. A graphical analysis usually gives such results in a visual comprehensive form. For these reasons the graphical method was chosen by the writer.

Obviously, if the sucker rods were wholly rigid then the motion of the plunger would be quite that of the polished rod. But sucker rods are elastic and their total length changes with the load. If we know the instantaneous load and its relationship to the stretch, and also the motion of one end of the rod system, then we should be able to plot the motion of the other end. This is the fundamental principle pursued in the analysis. The method best can be understood by referring to an actual analysis step by step.

Refer to Fig. 1. In the upper left-hand corner will be found the dynamometer card to be analyzed, so placed that the polished rod positions are read along a vertical line. Thus the upstroke is read upward and the downstroke is read downward, as indicated by the arrows. The load in lb. is read along the horizontal. Its area shows 48,800 ft-lb. of work, which is 21.5 hp. at 14.5 s.p.m. The peak load comes at the end of the stroke and is 26,000 pounds. The minimum load is 4000 lb. and comes at 26 in. from the bottom of the stroke. The stress range therefore is 22,000 pounds. On this card is drawn a line representing the static weight of the rods, which in this instance is 6000 lb., and is so designated.

Immediately to the right of the dynamometer card is drawn a semi-circle of 64 in. diameter to the same scale as the card. Since 64 in. is the stroke of the polished rod, then the projection of any point on the card to this circle will determine the relative crank position at the instant (disregarding the pitman length effect). A little thought will make a semi-circle suffice for this purpose. A curve marked "polished rod motion" is plotted with clock positions of the crank as abscissa and polished rod positions as ordinates. This of course is a simple sine curve and is obtained from the semi-circle. Now we have the motion of one end of the rod system and the instantaneous loads for every point in that motion, from which we should be able to plot the motion of the other end of the rod system. To do this a dotted line marked "rod stretch" is laid out on the card giving the rate of rod stretch due to dynamic load so that the stretch of the rod system may be found by simple projection of any point on the diagram to this line. The static weight of the rods are taken as zero stretch. Any shortening of the static length of the rod system is taken as negative stretch. The information necessary to lay out the curve of rod stretch on the card is obtained from a series of curves shown in Fig. 2. The rate of rod stretch is not of necessity the same for loads greater than the static weight of the rods as for loads less than the static weight of the rods. Hence we must

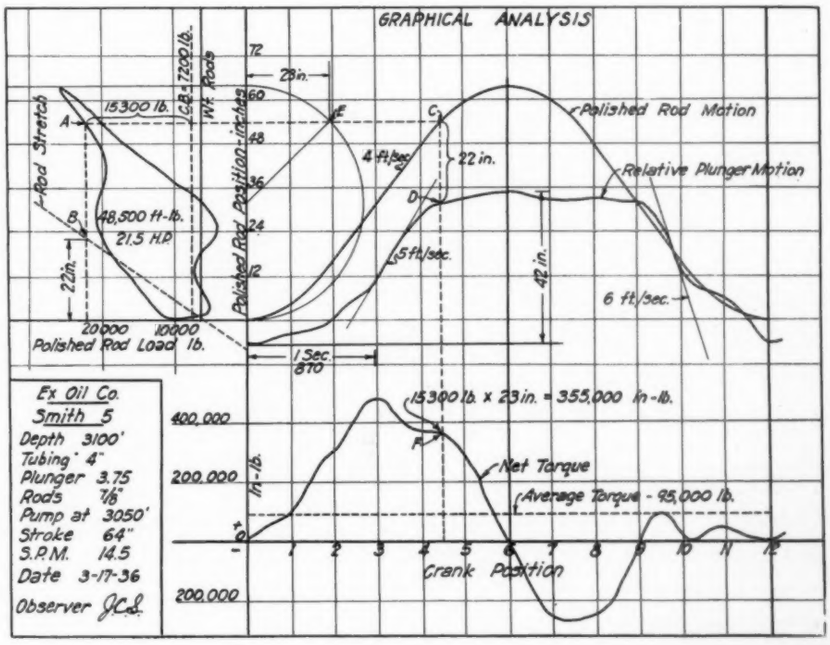

Fig. 1

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use two separate values for the rod stretch lines. To make this point clear we note that the rod system consists of 3050 ft. of 7/8-in. rods. Referring to Fig. 2 we see that 3050 ft. of rods would stretch seven in. due to their own weight. On the card a line is drawn from the weight of the rods to a point seven inches below the base line (negative stretch) on the atmospheric or zero line of the card. Again referring to Fig. 2 we find that 3050 ft. of 7/8-in. rods stretch 13 in. due to 10,000 lb. dynamic load. On the card a line is drawn from the weight of the rods through a point 13 in. above the base line (positive stretch) and 10,000 lb. above the weight of the rods (16,000 lb. total weight).

Now let us take any point on the card as the one marked "A." At this point the polished rod load is 22,500 pounds. Projecting this point downward it cuts the curve of rod stretch at the point "B," which shows a rod stretch of 22 inches. Projecting the point "A" to the right it cuts the curve of polished rod motion at the point "C." The point "C" gives the crank position as half-way between the four and five o'clock position. If from the point "C" we lay off downward 22 in., which is the instantaneous rod stretch, we arrive at the point "D." The point "D" therefore would represent the plunger position relative to the polished rod position. The operation of laying off the point "D" may be done with dividers, thus making it unnecessary to read numerical values. The curve marked "Relative plunger motion" is derived by plotting as many points from the card as is desirable.

We now have the plunger motion, from which we learn that the plunger traveled 42 in. while the polished rod traveled 64 inches. We note that the plunger motion is not so smooth as the polished rod motion and comes to a stop for a considerable portion of the cycle. This indicates that the plunger was much too large for the rod string. If we consider the motion of the crank to be uniform, then at 14.5 s.p.m., 87 deg. crank travel would be one second. Using this distance as a measure we may determine the velocities from the slope of the curves. The plunger acquires a velocity of five ft. per sec. on the upstroke and six ft. per sec. on the downstroke, while the maximum velocity of the polished rod was but four ft. per second. It may be argued that the crank motion is not uniform. However, the relative velocities will be in those ratios, the actual instantaneous velocity of the crank notwithstanding.

A curve showing the instantaneous crank effort in in-lb. torque also may be plotted. By drawing a line on the card to represent the effective counterbalance we may obtain the net load on the crank pin, it being the difference between the polished rod load and the effective counterbalance. This multiplied by the effective crank arm will give the torque. Going back to the point "A" on the card we see that its projection cuts the semicircle at the point "E." At that point the effective crank arm is 23 inches. The net crank pin load is 15,300 lb., which multiplied by 23 in. gives 355,000 in-lb. torque and is plotted at the point "F." By using this method the curve of net torque can be determined. The average torque may be calculated from the average hp. or from the ft-lb. given on the card. A check on the accuracy of the plotting can be had by averaging the torque curve by areas.

From this particular analysis we learn without question that the plunger size was far too large and the counterbalance was much too small. It is hoped that this method applied to specific problems will add to our understanding of the pumping problems. It is admitted that the analysis is not wholly accurate, yet it is perhaps within the error of measurement by the dynamometer and, therefore, of sufficient practical accuracy. Its error will not affect any important conclusion.

It is the intention to show in a later article the results of pumping speeds upon plunger travel by this method. This will afford a wider scope for a more complete discussion of the method.

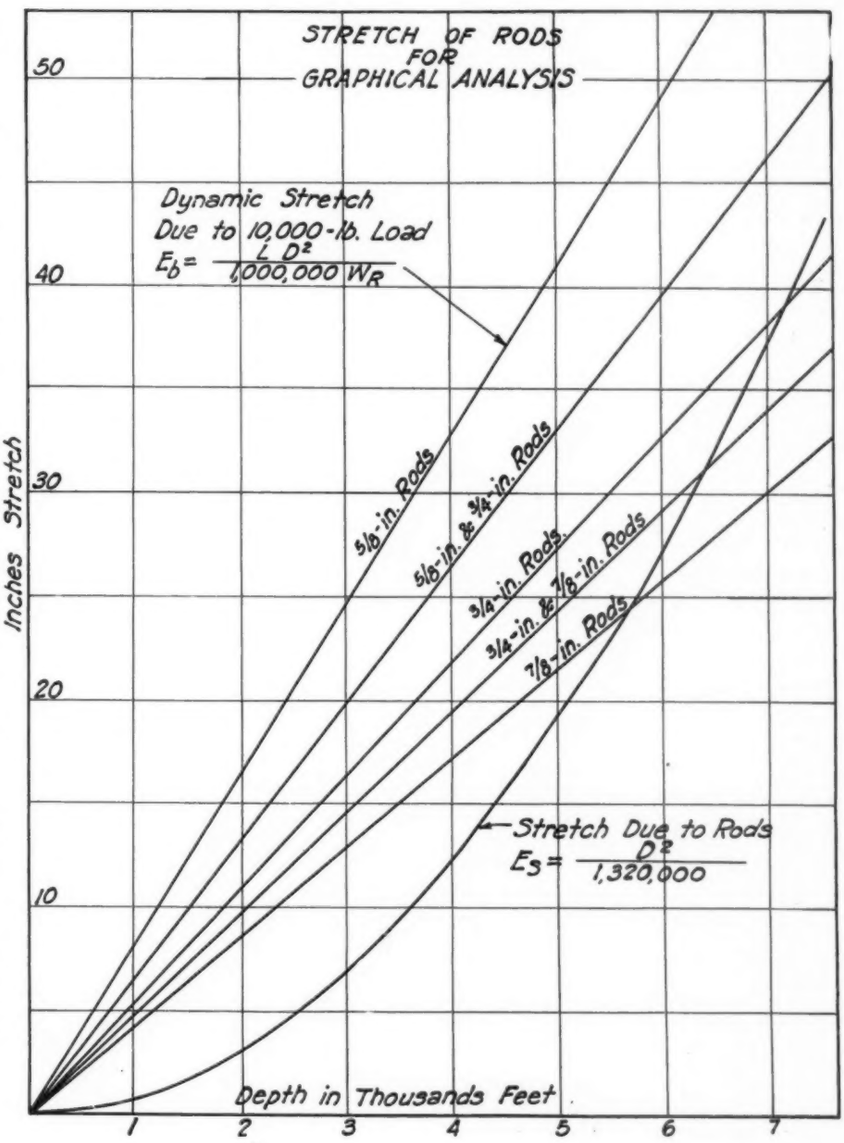


Fig. 2

The Voltolization Process for the Production of Premium Motor Oils

By GEORGE M. WOODS

Possible Industrial Method for Producing Premium Motor Oils

THE voltolization process is a method used for producing premium motor oils by subjecting mineral and fatty oils to the action of a high-tension silent electrical discharge. This process has been in commercial operation in Europe for many years and during the past five years has become very widely practiced abroad, due to the expiration of the original patents.

The voltolization process is carried out by subjecting the oil to be treated to the action of a high-tension silent electrical discharge of relatively high frequency, the oil being maintained under reduced pressure during this operation. The theory of the voltolization process appears to be the dehydrogenation of the treated oil by means of the electrical discharge, and subsequent polymerization of the olefin material formed. In carrying out the voltolization process the oil becomes more viscous as the treatment is continued.

Oils of extremely high viscosity index and oiliness are produced by the voltolization process. The viscosity index increase resulting from voltolization is much greater than is possible with solvent treating, and at the same time the oiliness properties of the oil are remarkably improved.

Paraffin wax, petrolatum, or oil may be polymerized by the silent electrical discharge to form oils of high viscosity index. A part of the unreacted material always remains and must be removed by vacuum distillation. The viscosity and yield of the voltolized oil both vary directly with the intensity of the electrical treatment. Depending upon the intensity of the electrical treatment, two types of oil may be prepared. Mild voltolization produces oils of viscosities of 115 to 240 seconds at 210 deg. fahr. and yields of from 15 to 40 percent of 120 viscosity index from the charge to the process. Longer and more intense voltolization produces highly viscous oils of 500 to 2500 seconds viscosity at 210 deg. fahr. and yields of 50 to 75 percent of approximately 380 viscosity index blending value. These latter highly voltolized oils also have the remarkable property of lowering the pour point of oils to which they are added in small quanities. Thus it may be seen that the voltolization process produces a highly viscous product that when added to lubricating oil raises the viscosity index and lowers the pour point. The desirability of producing a high viscosity index blending stock and a pour point inhibitor led to experimental work on the voltolization process.

The design of the laboratory apparatus was copied more or less in detail from the commercial voltolization units in operation in Europe. A diagram of the laboratory apparatus used is shown in Fig. 1. It consists essentially of rotating electrodes that dip into the oil during each revolution. The container is kept half full of oil at all times in order that each electrode comes in contact with fresh oil as it is revolved. Oil also is poured down the space between the electrodes

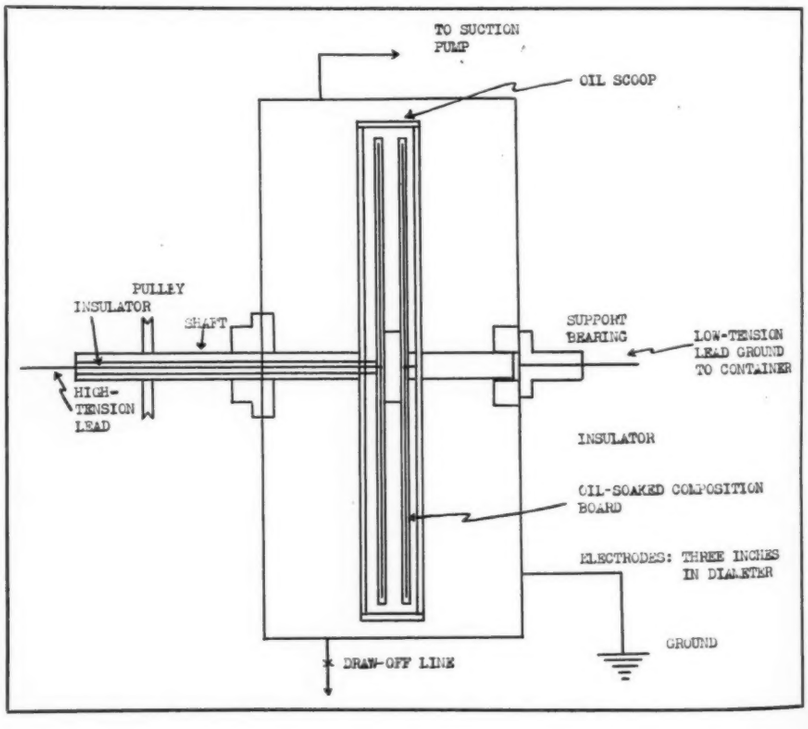


Fig. 1. Diagram of laboratory voltolizer cell

by oil scoops on the periphery of the rotating electrodes. This design of the voltolization apparatus insures positive contact and washing of the electrodes with fresh oil, and prevents any over-voltolized products from building up on the electrodes. A diagram of the electrical equipment and connections used on the laboratory voltolizer is shown in Fig. 2. After considerable trouble with the insulation of the electric leads on the laboratory voltolizer, several runs were made in which the apparatus performed satisfactorily.

An example of the voltolization process carried out on a blend of 50 percent crude scale wax (120 deg. fahr. melting point) and a 50 percent waxy Mid-Continent overhead oil will be given.

In order to produce a low viscosity voltolized oil the voltolization process was carried out until power of 15 kw-hr. had been consumed per gal. of finished voltolized oil. After voltolization the light oil was distilled from the voltolized oil under vacuum. The yield of voltolized oil was 19 percent of the oil charged. The overhead oil was recycled through the voltolizing chamber so that no actual loss occurred. This voltolized oil was then dewaxed, and the dewaxed oil contacted with 0.25 lb. per gal. of Filtrol clay at 500 deg. fahr. Inspection data on the oil was:

Gravity, 32.2 deg. A.P.I.
Flash Point, 535 deg. fahr.
Fire Point, 600 deg. fahr.
Viscosity at 100 deg. fahr., 1105.
Viscosity at 210 deg. fahr., 121.7.
Viscosity Index, 123.
Pour Point, 15 deg. fahr.
Color, Robinson, 3½.
Carbon, 0.69 percent.

The estimated production cost of the above high viscosity index motor oil is estimated to be about 38 cents per gallon. This estimated high cost of production throws some doubt on the feasibility of this method of using the voltolization process, but the power consumption may be considerably higher than in actual plant practice.

An example of the voltolization process carried out on a blend of 50 percent crude scale wax and 50 percent waxy Mid-Continent overhead oil for the production of a viscous blending agent will now be given. The voltolization was carried out until power of 60 kw-hr. had been consumed per gal. of finished voltolized oil. After voltolization the light unvoltolized oil was distilled from the voltolized oil under vacuum. The yield of voltolized viscous oil was 57 percent of the oil-wax mixture charged to the voltolization step. The overhead of course was recycled through the voltolization cell. The viscous voltolized oil was contacted with 0.25 lb. of Filtrol clay per gal. of oil at 500 deg. fahr. and filtered. Inspection data on the filtered oil follows:

Gravity, 31.8 deg. A.P.I.
Flash Point, 575 deg. fahr.
Viscosity at 210 deg. fahr., 349.4.
Pour Point, 70 deg. fahr.
Carbon, 0.74 percent.
Color, Robinson, 1½.

The cost of producing the above viscous oil has been roughly estimated at 45 cents per gallon.

The above-produced voltolized viscous oil has remarkable properties. Thus when added to a finished Mid-Continent paraffin-base motor oil in the ratio of 90 parts motor oil to one part voltolized oil the viscosity index of the motor oil is raised from 90 to 119. The actual results follow:

	Mid-Continent Motor Oil	10% Voltolized Oil 90% Mid-Continent Motor Oil
Gravity, deg. A.P.I.	29.2	29.3
Flash Point, deg. fahr.	460	460
Viscosity at 100 deg. fahr.	387	413
Viscosity at 210 deg. fahr.	56.3	64.0
Viscosity Index	90	119
Pour Point, deg. fahr.	10	0
Carbon, percent	0.68	0.60
Color, Robinson	9¼	8¼

The results of adding various amounts of highly voltolized oil to a 30 deg. fahr. pour point paraffin-base motor oil follows:

30 deg. fahr. Pour Point Oil, Percent	Voltolized Oil, Percent	Pour Point, deg. fahr.
100	----	30
99	1.0	10
98	2.0	—5
95	5.0	—15

It would appear from the preceding data that refiners should study the voltolization process as a possible industrial method to be used in the United States. The quick acceptance of Paraflow, a pour depressent, and Exenol, a viscosity index improver, both of which are manufactured by the Standard Oil Development Company has shown the possibilities of such compounds.

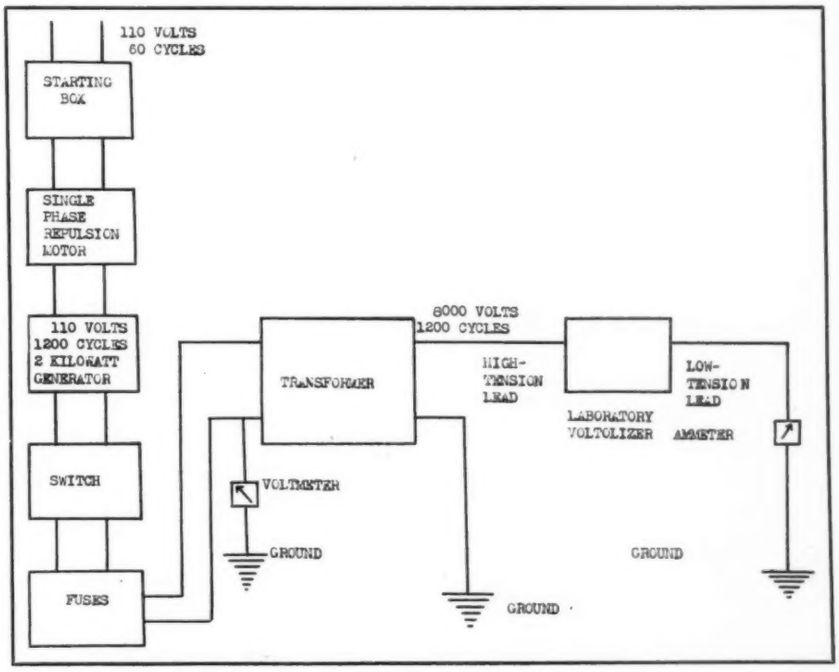


Fig. 2. Electrical hook-up of laboratory experimental voltolizer

Sucker Rod Fatigue and Corrosion[1]

TO the casual observer, a sucker rod is probably nothing more than an elongated bolt or bar of steel, with upset ends, threaded to be screwed together when run into a well. However, to the production engineer or superintendent who has battled with ever increasing lifting costs it is one of the most important items of oil pumping equipment.

At first the most common workable metal used was wrought iron. The necessity for greater strength and lower cost soon brought soft steel into use. When the limit of the strength of soft steel was exceeded, it was necessary to resort to steels of higher carbon content. Later, steels with the element manganese increased to give additional strength, solved the problem for a time. About this time, manufacturers became aware that something had to be done in addition to changing the composition of the metal and resorted to the addition of nickel and other alloys, and to heat-treating in various forms.

There are three general classes of sucker rod service, namely: (1) In wells where we have stress only to consider; (2) where we have corrosion in addition to stress; (3) where we have stress in addition to the severe embrittling action of hydrogen sulphide gas in conjunction with corrosive fluids.

Where stress only is to be considered, and it is definitely known that there is no corrosive condition, sucker rods when overloaded, fail from fatigue only. Surface defects such as nicks, cuts or pits, especially at a vital point, such as the section adjacent to the upset, are the start of such failures that shorten the life of the rod materially.

The second type of service, referred to above, presents several complications, as the problem is not only one of resistance to stress but also to corrosion, of which there are two types. The first takes place in unstressed metals, such as tanks, pipe lines, casing, etc., and is known as "static" corrosion. Evidence of this is in the form of pits or wasting away of the metal. When a statically corroded member is later subjected to stress, its decrease in fatigue resistance is due to the fact that these pits caused either stress concentration or a reduction of metal area.

Unstressed corrosion, however, is not often a factor in sucker rod life as only in the case of a string of rods hanging in a "down" well should we expect to encounter this condition. Usually the corrosive fluid attacks the rods in the presence of stresses that are set up by the pumping cycle. We call this "stress corrosion" which in turn causes "corrosion fatigue" or "corrosion embrittlement fatigue." The corrosion fatigue value of a metal is always lower than its fatigue value in air.

The effect of stress concentration due to pits or notches is familiar to most of us, as we have observed how easy it is to break a stick of wood or bar of steel when a notch has been cut in it and how difficult it is to break a similar bar or stick that has a smooth surface. It is not so much that the area of the bar has been reduced at the root of the notch but rather the notch has actually reduced the fatigue resistance of the bar. This can be proved by making fatigue tests on specimens having various types and sizes of notches. Some metals are damaged more by a given type notch than others, and for corrosion-fatigue-resisting sucker rods, we should use that metal which inhibits to the greatest degree the formation of fine notches or shallow pits and offers the greatest resistance to their growth.

The third type of well service—hydrogen sulphide embrittlement and corrosion—is the most severe, and probably more effort and money have been expended on the development of sucker rods for this type service than upon all others.

In the early investigations it was clearly demonstrated that the ordinary metals then used for sucker rods were not suitable for rods operating under sulphide conditions, especially when subjected to stresses approaching 30,000 lb./sq. inch. Now, after years of experiment and investigation, it has been determined that ferrous metals containing moderate percentages of carbon and manganese are not desirable for this type of service.

The successful rod for corrosive and sulphide service should have the following characteristics, which are listed in the order of their importance: (1) Inherent resistance to corrosion and embrittlement; (2) uniformity of composition and physical condition to eliminate localized zones of corrosive attack; (3) sufficient fatigue resistance to allow the highest possible operating stresses; (4) extreme toughness, ductility and resistance to stress concentration; (5) cost that is commensurate with service rendered.

The table below shows the results of "slow-speed" sulphide fatigue tests on several types of sucker rod metals, arranged in the order of their values as determined by this test. These results have been fairly well confirmed by actual service in the field.

Material and treatment	*Cycles of reversals of stress to cause failure*
Low carbon 3½% nickel-molybdenum steel* (normalized, quenched and drawn)	1,266,130
3% nickel wrought iron, normalized	850,050
.30% carbon copper-nickel steel (quenched and drawn)	790,000
.14% carbon, 2% manganese steel (quenched and drawn)	737,300
SAE 1050 carbon steel (normalized, quenched and drawn)	702,400
Engine bolt refined plain wrought iron (no heat treatment)	330,700
Peak computed stress	30,000 lb./sq. in.
Stress range	60,000 lb./sq. in.
Speed of stress reversals	36½ per minute
Temperature of synthetic well fluid	80° — 90° F.

(Grade "S", produced by Oil Well Supply Co.)

Course in Mechanical Engineering

The University of California Extension Division, Berkeley, California, announces a class in mechanical engineering, commencing September 23, covering the principles of thermodynamics, heat transfer, and fluid mechanics as applied to the design of equipment for petroleum distillation. The classes will be held in the Engineering Building, and the instructor will be Frank L. Maker, mechanical engineer, of the Standard Oil Company of California.

This course is intended for engineers interested in the design of distillation equipment, using as examples problems from the petroleum industry. The course will be divided into three separate parts, and eight two-hour meetings will be held for each part. Enrollment fee is $6.00 for each part; registration fee $1.00.

Made Sales Representative

D. H. Skeen & Company, One LaSalle Street, Chicago, managed by Kenneth Williams, have been appointed sales representatives for the George P. Reintjes Company for the sale of their supported walls and arches in the Chicago area.

[1]Gist of an article by F. B. Bayless, metallurgist, Oil Well Supply Company, Oil City, Pennsylvania, appearing in *Nickel Steel Topics* under the title "Nickel Alloys Resist Sucker Rod Fatigue and Corrosion."

Drilling Muds . . . Their Properties and Methods of Treatment

By K. H. CLOUGH*

ALTHOUGH thousands of words have been written concerning drilling mud, and countless experiments have been carried on in an effort to solve the important problems connected with this phase of drilling operations, some of these problems remain unsolved, and until they are solved the question of deeper drilling will remain clouded with doubts and risks.

In this, the first of a series of two articles, the properties and methods of treatment of drilling muds will be discussed. In the second article, heaving shale, one of the most frequent and troublesome problems of the driller, will be discussed, together with actual data on mud treatment of drilling wells; also, the results of a successful experiment with heaving shale will be disclosed.

At the outset it may be well to outline briefly the chief functions of a rotary drilling mud:

A mud should serve as a lubricant for each piece of equipment with which it comes in contact, since the drill pipe, casing, and the slush pump are lubricated in this manner. It should seal or coat the walls of the well, thus preventing the loss of drilling mud by penetration into porous formations. It should wall-up the hole and consolidate or bind the loose formations. It should remove all cuttings from the well as rapidly as they are formed. It should be sufficiently liquid during circulation to allow the cuttings removed from the hole to settle in the slush pit and ditch, yet have sufficient tendency to gel to hold all solids in suspension during shut-down periods and periods of no circulation. This characteristic prevents cuttings from settling around the drill stem. Lastly, it should provide enough hydrostatic pressure, that is, it should have sufficient weight to confine to their respective formations any oil, gas, or water encountered.

From the foregoing it may be gathered that a serviceable drilling mud should have approximately the same consistency while circulating as a good, medium lubricating oil. It should be amply fluid during circulation to drop cuttings after entering the slush ditch and pit, and it should set to a soft, easily broken gel upon standing quiet for a short time. This gel should be viscous enough to hold or retain in suspension all cuttings. It also must be reversible; that is, the mud should return to a fluid state upon slight agitation, either by starting the pump or by rotating the drill stem and drill in the hole.

Thus, when no pressure zones are encountered during drilling, the mud acts only as a transporting, sealing, and lubricating medium. For the correct performance of these various functions it is vitally necessary to control the concentration and the character of the colloidal material in the drilling mud. Several methods of control are available to the operator. The solids present may be increased or decreased, thus increasing or decreasing the weight of the mud and proportionately the hydrostatic pressure. The solids may be changed in character, altering the fluidity and gelling properties of the mud.

The solids present in drilling mud may be divided into three groups or classes: suspensoids, crystalloids, and colloids. This grouping is governed by the size and character of the solids.

The suspensoids include those particles that are relatively large in diameter and vary in size from coarse cuttings from loose or non-compacted formations down to particles approaching colloidal dimensions. The suspensoids do not affect materially either the physical or the chemical properties of the mud, since usually being of lesser specific gravity than the weighting material employed in the mud, they are incapable of increasing the weight of the mud; furthermore, suspensoids usually are dropped in the slush pit or ditch during each circulation cycle of the mud.

In general, suspensoids are considered detrimental because their presence in the mud causes abrasion of the pump and drill stem, so it may be said that they are injurious to the lubricating properties of the mud. It is very desirable, therefore, to remove as much of the suspensoids as possible before recirculating the mud.

The second group, the crystalloids, consists of that portion of the solid matter held in true solution. This class includes the various soluble salts found in the different strata, and unless other salts are encountered whose chemical reaction with the crystalloids already present results in either a precipitate or in a gaseous formation, the crystalloid content of the mud will increase until the saturation point is reached.

It is almost impossible to remove this class of material from the drilling mud and its presence in moderate amounts is not particularly objectionable; however, if the concentration of the crystalloids becomes excessive, it tends to coagulate the colloidal material and cause it to settle out of the water. It is extremely important, therefore, to prevent this concentration from being reached, as this would result in the loss of the colloidal material, without which the drilling mud would be rendered useless for its intended purpose.

It is possible to wash out most of the crystalloids by removing the mud from the well and washing it repeatedly with water. The crystalloids will be much more soluble in the wash water than in the drilling mud, which at the time of washing is saturated with crystalloids, colloids, and suspensoids. This method of handling, however, is very costly and unless there is a shortage of drilling mud or unless mud costs are unusually high, it usually is advisable to discard the spent mud and replace it with a fresh supply. One fact that tends to hinder the removal of the crystalloids from the drilling mud is the gelling tendency of the mud on setting, with the resultant absorption of water.

The colloidal material present in drilling mud lies between the crystalloids and the suspensoids in respect to

*Chemical Engineer, W. H. Curtin & Co., Houston, Texas.

size, since the colloids are not in true solution but are so finely divided as to remain in true suspension. The colloidal particle approaches molecular dimensions but is not present in true solution as is the crystalloid. On the other hand, the colloid cannot be separated from the dispersing medium by ordinary methods of filtration. Virtually all the so-called weighting materials, sold commercially under various trade names, are divided so finely that they will pass through a 325-mesh screen. They may be termed "air-floated."

Different colloidal materials have widely different properties, and it is these widely different properties that necessitate a study of drilling mud. Some colloids will pass from the fluid colloid-carrying state to the gel form, where the entire mass gels or sets, but cannot be returned readily to the fluid state. Such colloids are termed non-reversible. Other colloids can be converted from the fluid form to the gel state and back to the fluid form again very easily and this conversion or cycle can be repeated indefinitely. Such colloids are termed reversible.

To the driller a reversible colloid is a necessity. A non-reversible colloid is objectionable, for when such a colloid gels the driller has the problem on his hands of breaking this gel. In other words, to continue drilling he must get his mud back to the fluid state. If this cannot be done he may lose the hole or his string of tools or be faced with a costly job of recovering the drill pipe. There are three gel types: the acid, the alkaline, and the neutral. Some of these will respond to known chemical treatment, whereas others as yet have not been broken.

The ideal colloid for drilling is one that will remain in the liquid or fluid state as long as circulation of the drilling fluid is maintained. It should set to the consistency of a soft gel soon after circulation ceases and the fluid becomes stationary. The soft gel thus formed should return to the liquid state readily upon slight agitation.

A mud containing the ideal colloid would perform effectively all the functions of a drilling mud, such as lubrication, transportation, and sealing, except that of providing a hydrostatic head to overcome any high pressure that might be encountered. Thus it may be seen that the kind of colloids present is very important. We shall see that the amount of colloids present also is important — probably equally so.

So long as a satisfactory drilling mud remains in the liquid state, the cuttings or suspensoids that are produced by the bit will tend to settle out of the mud. The rate at which these particles settle will depend both upon the specific gravity of the particles, the density of the liquid or fluid, and the size of the suspensoidal particle. This relationship may be expressed mathematically in the form known as Stokes Law, which is as follows:

$$V = \frac{2(D-d)}{9Y} \quad gr^2$$

where:

- V = the velocity or rate of settling in cm./sec.
- D = the specific gravity of the particle
- d = the specific gravity of the liquid
- Y = the viscosity of the liquid
- g = the acceleration or force of gravity, which may be taken as 98L
- r = the radius of the particle in cm.

Thus it may be seen from this relationship that if the gravity of the suspended particle is greater than the gravity of the liquid or fluid in which it is suspended it will tend to sink to the bottom of the well, even though the viscosity of the drilling mud be very great. This rate of settling, "V", must not equal or be greater than the circulation rate of the drilling mud, by which is meant, that as long as the rate of mud circulation maintained is such that the linear velocity of the mud itself, as it circulates from the bit to the slush pit, is greater than the settling rate or velocity of the suspended particles downward, that these particles will be brought to the surface. Thus, while they tend to settle to the bottom of the hole, they nevertheless will be washed out of the well by the flow of the liquid. Upon reaching the surface the mud flows through a slush ditch to a slush pit and while so doing its direction of flow is horizontal instead of vertical. The gravitational or settling force of the suspensoidal particles being still in a downward direction, the particles will follow a path that is a resultant of the two forces and will settle out in the bottom of the ditch and in the slush pit.

It can be seen that for the purpose of removing cuttings or other suspensoidal particles from the hole, a mud having a relatively low viscosity while fluid or moving is satisfactory, because the low viscosity gives a free-flowing mud that requires only low pump pressures to produce and maintain the required volume for circulation. This low-viscosity mud will have excellent lubricating properties; will remove cuttings efficiently as long as the circulation rate is in excess of the settling tendency of the largest suspensoidal particles; will promote the settling of the cuttings in the ditch and the pit; can be circulated with low pump pressures; and is self-cleansing of the coarse material or suspensoids, the presence of which would cause considerable abrasion of pump parts and drill stem.

It has been demonstrated in actual field practice that a rotary drilling mud of low viscosity is advantageous in being able to function thus. Low viscosity, however, becomes disadvantageous when it is necessary to stop circulation or when circulation is impaired or lost, as in the case of encountering a porous formation. When circulation is stopped there remains no vertical force to counteract the settling tendency of the suspensoids. The lighter or less viscous the drilling mud, the more rapidly these particles will settle. Consequently, all suspended matter in the hole at the time circulation is stopped eventually will settle to the bottom and usually can be brought back into suspension by rotating the drill stem and renewing circulation. The suspended matter thus settled out may at times pack in the hole so tightly that rotating the drill stem with renewed circulation will not work; in fact, the compaction may be complete enough to prevent the drill stem from being rotated. Under these circumstances it may require as much time to work the sediment back into suspension as was required to drill an equivalent footage originally; furthermore, if the settling rate of the suspended matter is high and the drill stem is not removed promptly when circulation stops, the compaction may be so complete that the drill stem cannot be removed or rotated.

This usually results in a twist-off, and a fishing job. The time lost is important, but the possible loss of the hole is even more important. Thus it can be seen that though low viscosity usually is beneficial it may under certain circumstances be injurious, in which case low viscosity sometimes must be sacrificed for gelling properties and weight.

View of standardized fire hall on a farm in Oklahoma. It comprises three rooms, equipment room, machine shop room, and water tank room

By

JOSEPH A. KORNFELD

Combating Tank Fires at Oil Storage Tank Farms

RIVALLING the efficiency of modern metropolitan fire-fighting units, one large oil company maintains at all its tank farms standardized fire walls and equipment, and follows a specific fire-fighting routine. Among the advantages cited are the prevention of damage to adjoining tanks, salvaging of oil in the burning tank by exhaustion, reduction of fire-fighting costs, and safety measures designed to reduce injury to employees as well as prevent fires by maintenance of tanks. Details of methods, machinery, and routine are discussed in this article.

Although tank fires at oil storage farms can be prevented effectively by systems of static discharge wiring, breather-type roofs, gas-tight tanks, and correctly-designed firewalls, yet a system for efficient fire-fighting, including equipment and standardization of methods, is essential.

Fire-Fighting Methods

Modern fire-fighting methods in use at oil storage farms comprise the use of cannon to combat "boil-over," the use of steam to fight flames, the exhaustion of oil from tank during fire, erection of firewalls, and, to a minor extent, the use of "flare-back" sheets.

Prior to 1921, wooden-type roofs were the vogue. Since that time tanks have been made gas-tight with sealed steel roofs. A modification is the Wiggins breather-type roof.

The most common cause of fires is leakage of highly-volatile gases from the oil and then ignition by direct or indirect strokes of lightning. Other causes are man-made, exemplified in a variety of ways. Still others are accidental, falling equipment, etc.

When a tank is ignited from a lightning discharge, the fire first burns around the eaves, cutting down the first three feet of the tank's walls. Sometimes, on direct stroke, the roof is blown off. In the case of ignition of a wooden tank, the roof usually will collapse within two to three hours from the time the fire starts.

Oil storage tanks are of the following capacities:

35,000-bbl.	standard
37,500-bbl.	odd
55,000-bbl.	standard
80,000-bbl.	standard

An idea of the magnitude of tank farm investment is learned from the fact that on one tank farm alone there are one hundred and fifty 80,000-bbl. tanks—the Clayton, Wyoming, tank farm of the Stanolind Crude Oil Purchasing Company—with a combined storage capacity of 12,000,000 barrels.

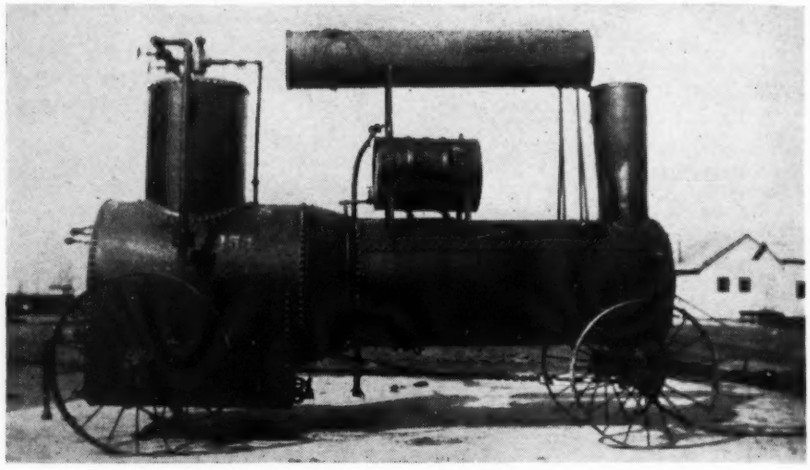
"Boil-Over" Phenomenon

A phenomenon occurring in tank fires is "boil-over." This takes place from six to eight hours after the oil in the tank starts burning. Boil-over is caused by the presence of "heavy-ends" in the crude and water, steam being generated in the tank. Generally, the more water the tank contains the sooner will it boil over. An experienced fire-fighter usually can determine the time of "boil-over" by observation. The oil in the tank boils over, making a loud hissing noise as the steam escapes from the oil. From the viewpoint of personal safety, the heat is so intense that men standing 200 yards from the tank, in some instances, have been blistered during fire-fighting operations.

Preliminary Precautions

In the event of a tank fire on the property, employees are instructed to advise the foreman and the main office, using telephone, telegraph, or messenger.

Immediately all employees rush to the fire hall where the equipment is kept, and remove the boilers, tools, flare-backs, cannon, pipe, fittings, etc. and transport these to the scene. First the firewall drain lines of the burning tank (both inside and outside of open-



View of standardized boiler used in combating oil fires at crude oil storage farms. Note the portability of the unit and the hinged section of smokestack to enable the unit to be stored inside the fire hall

ings) are plugged, using a wooden plug, over which earth is packed to protect it from the heat. If the tank is disconnected the plug is removed from the gate valve and a gate opener attached ready for instant use outside the firewall. Necessary connections and arrangements are made for saving oil by either gravitation or pumping. Lines are laid for the boiler, including fuel oil line for power and outlet line for use of steam.

Boiler. A 20-hp. boiler mounted on wheels is set up as close as possible to the burning tank. Water is supplied by 8-bbl. water wagons that are pulled from the fire hall to the scene of the fire. Hand-pumps are connected to the water pond. In unusually wet weather as many as six horses are employed to pull the boiler to the most advantageous location on the windward side of the tank, so as to prevent spouted oil from falling on the men at the boiler. Steam is used to smother the flames and to prevent further boiling of the water in the tank. So long as the tank is burning, steam is maintained in the boiler and is not turned off until all danger has passed.

Fire-Wall Erection. In connection with the actual fire-fighting, men and teams are utilized in throwing up firewalls to confine the boiling oil to a close radius of the tank. All fire halls are equipped with 100 long-handled shovels, one plow and four slips used in connection with the plow. It is not unusual to work 100 men around a single fire.

Protection of Adjoining Tanks. For the protection of all adjacent tanks, wooden stairs are removed after the hatches are properly covered. All gate valves and manheads are heavily covered with earth, and all drain lines plugged. Low spots in the firewalls on adjacent tanks are raised.

Flare-Back Sheets. For protection of the fire-fighters and for reflecting the intense heat and spouting sprays of oil, flare-back sheets are used, a method utilized by this company as early as 1926. "Flare-back" sheets are made of ⅛-gauge steel, being ten ft. in length and 18 in. in width. Groups of these, stored in the fire halls, are placed in position on top of the firewalls. Stakes are employed, these being ¾-in. round pegs from two to three inches in length. These are driven into the ground with sledge hammers to hold the sheets in place, being placed on both sides at the base. Curved sheets are used for flare-back sheets. In instances where firewalls are not necessary, the "flare-back" sheets are set directly on the ground.

Use of Cannon to Fight "Boil-Over." Civil War cannon, reconditioned for fire-fighting use, are utilized for combating the "boil over" by the expedient of shooting holes in the rings of the tank. Shooting of the tank plates is not resorted to until all other precautions have been taken. The object of shooting is to lessen the "boil-over" and to spread the boiling oil over as large an area within the firewall as is possible. The danger of allowing "boil-over" to occur is that flaming oil is thus expelled over a wide area, causing extreme danger to adjacent tanks and fire-fighters.

As a rule four or five hours are allowed to elapse before use of the cannon is resorted to. When its use is deemed advisable, however, the most convenient procedure is to place the cannon on an automobile truck, moving it around to various sides of the tank for strategic firing positions. An additional advantage of this method is the added elevation that aids in firing at the objective, the first ring on the tank. The instant the shot penetrates the tank plates, the boil-over diminishes. The more times a tank is shot,

View of 100-bbl. water tank installed on tank farm of oil company in eastern Oklahoma. Note the concrete foundations

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Showing chain transmission from engines to drawworks and pumps.

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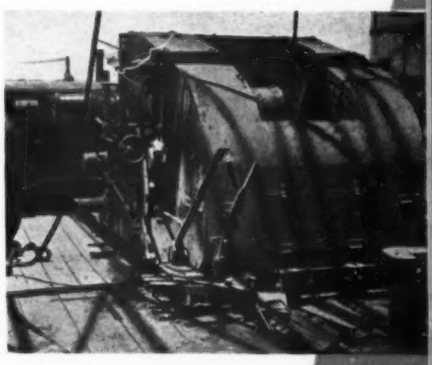

Showing front view of drawworks and control.

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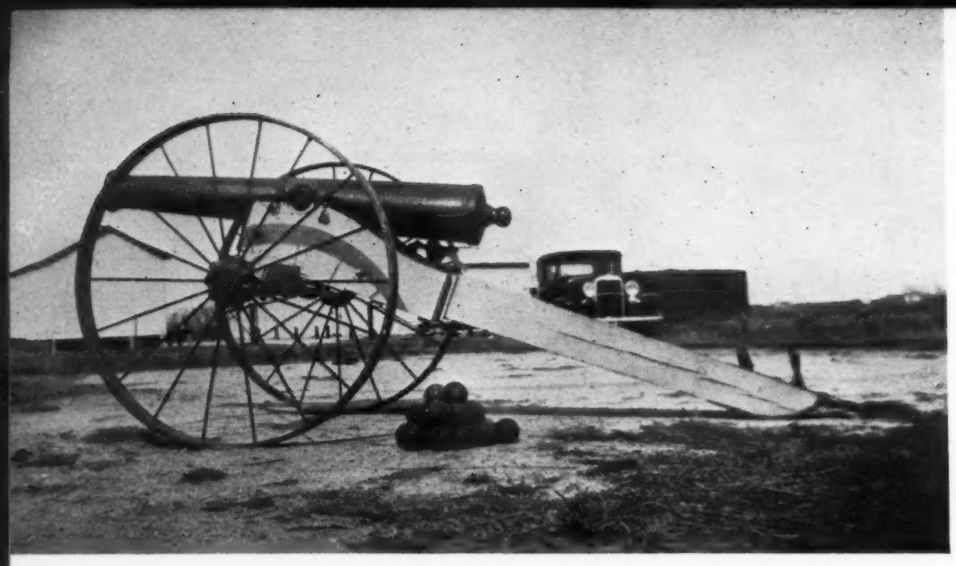

Side view of cannon used by pipe line company in combating crude oil tank farm fires. It is used to prevent "boil-over" in the ignited tank through shooting holes in the side plates of the tank.

naturally, the less the boil-over. In one instance 21 holes were shot with effectiveness into a single tank.

The first boil-over period is the most dangerous. The extent of the danger depends on the volume of water and the height of the crude in the tank. At the moment of boil-over the first two top rings act as a curtain, the rings being red hot and soft under the terrific temperature. It is always advisable to get the equipment to a place of safety after seven to seven and one-half hours.

Following a fire usually nothing of value remains. In some instances it is possible to salvage the tank bottoms, due to the low burning temperature of the basic sediment and the water. Use of gas-tight tanks and flame arresters reduce the frequency of oil tank fires.

Methods of Exhausting Crude Oil from Tank. When the burning tank is so situated that the crude oil can be moved by gravitation to another empty storage tank, gravitation alone is used. More often a suction pump is necessary, one capable of obtaining 20 to 25 inches of vacuum, pumping through 6-in. and 8-in. lines. The pump specifications call for 10-in. pistons with 12-in. stroke and 150-lb. working pressure.

Standard Construction

Fire Hall. The fire hall is of standardized construction, measuring 16 ft. in width and 24 ft. in length. Walls are of sheet-iron, material of 14-in. width. being used. This hall houses a mounted boiler with hinged smoke-stack, a water wagon, and a small machine shop. All halls are constructed with concrete foundations throughout. Standard cost of construction and installation is $7,500 per station. The double door on each end of the hall is an exceptional feature. The design used by the major company whose system is here discussed is that worked out in 1928 by their own architect.

Boiler. Each fire hall is equipped with a single boiler mounted on wheels. The boiler has a short stack mounted on hinges for lowering to horizontal position for storage within the structure. The boiler is tested once yearly in the spring, when it is fired and cooled a number of times, being cleaned and checked for leaky flues and gaskets and refired after cleaning.

Tools. A complete list of all equipment is posted on the bulletin board at each fire hall and a copy mailed to the main office. An inventory, checked on a printed list, is taken quarterly. The quantity, type, and position of all tools are standardized for efficiency and economy. All tools are painted red for easy identification. The color also indicates emergency use so that it will not be taken out of the hall for other purposes.

Cannon. Target practice is held frequently on each tank farm to familiarize the force with the cannon and firing accuracy. Old tanks are most commonly used for targets. The cannon powder and primer is tested quarterly.

Relay Water Tank. A 100-bbl. water tank is situated at a strategic point on the tank farm. It has steel angle iron supports and is mounted on a concrete base. Four-hp. Novo engines are used to pump the fluid, their capacity being 25 bbl. per hour.

Grass-Burning. Another method of fire-prevention is the burning off of all grass on the tank farm premises. This is accomplished the first of each September. From six to eight men are employed at a time on this project. One water-wagon team accompanies the group to confine the grass-burning to small areas at a time, until the entire plant is cleared of all surplus growth.

Fire Wall Construction

Diameters. In the construction of firewalls for permanent maintenance, the diameter depends upon the size of the tank it is to protect. The following is standard practice:

35,000-bbl. tank..... 70-ft. dia. firewall

55,000-bbl. tank.....100-ft. dia. firewall

80,000-bbl. tank.....125-ft. dia. firewall

Heights. Height of firewalls vary from 20 in. to 42 inches. A slope of 1½ to 1 is used. However, where the tank is situated lower topographically, the firewall is built higher than the usual height to protect the tank from the flow of the adjacent tank that is situated on a higher elevation.

Grading. Firewalls are staked off by the engineer. Grading is let to a contractor at a certain specified price per cubic yard. The number of cu. yd. involved in one firewall project varies from 2000 to 4000. The number of men and teams utilized depends upon the nature of the soil. In practice, it is important to remember: *Cut a grade, never fill a grade!*

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H. W. BELL of Shreveport, Louisiana, has been made head of the Rodessa Engineering Committee, which will serve as a fact-finding body to assemble technical data on the field and make recommendations to the recently-formed Rodessa Operators' Committee, organized for the purpose of eliminating wastage of natural gas. Assisting Bell on the engineering committee are **R. O. GARRETT** of the Arkansas-Louisiana Gas Company, **F. R. SCHROEDER** of the United Production Company, **N. C. SCHEBLE**

R. W. BELL

of the McAlester Fuel Corporation, **W. B. POWERS** of the Magnolia Petroleum Company, **R. W. STEWART** of the Phillips Petroleum Company, **W. C. GORDON** of the Shell Petroleum Corporation, **S. S. ROBERTS** of the Standard Oil Company of Louisiana, and **GEORGE NYE** of the Tide Water Oil Company.

Bell is well qualified for his new post, having seen service with the United States Bureau of Mines, the Petroleum Division of the State Mining Bureau of California, the Louisiana Department of Conservation, and with various company organizations.

T. W. JOHNSON, formerly with the United States Bureau of Mines at Bartlesville, Oklahoma, has joined the staff of the United Gas Public Service Company as a petroleum engineer. His headquarters are at Shreveport, Louisiana.

R. VAN A. MILLS, who has been chief petroleum engineer for the Continental Oil Company, has been made proration engineer. **E. O. BENNETT** becomes chief petroleum engineer. **MIKE H. SHANAHAN,** formerly superintendent in the Wichita Falls, Texas, district, succeeds to Bennett's vacated post as assistant manager of production and drilling. **GEORGE F. BEEKMAN** has been transferred from the Olney, Texas, district to Wichita Falls and placed in charge there.

EDWIN L. RAWLINS, who since 1923 has been with the United States Bureau of Mines at Bartlesville, Oklahoma, on September 1 joined the staff of the United Gas Public Service Company. He will do petroleum engineering work for that organization and will have his headquarters at Houston, Texas. Rawlins, who is well known for his research work and field investigations on natural gas problems, was graduated in mechanical engineering from the University of Texas in 1922. Before joining the Bureau of Mines in 1923 Rawlins worked for a short time as junior engineer for the Empire Companies at Bartlesville, Oklahoma. At the time of severing his connection with the Bureau of Mines, Rawlins held the rank of senior petroleum engineer and was in charge of oil and gas recovery studies now being conducted by the Petroleum and Natural Gas Division of the U. S. Bureau of Mines from the petroleum experiment station at Bartlesville, Oklahoma.

J. C. HILTON has resigned as president of the Standard Oil Company of Louisiana and will return to New York City as vice-president of the Standard Oil Company of New Jersey (Delaware). **M. J. RATHBONE, JR.,** vice-president and general manager of the Standard Oil Company of Louisiana, will succeed Hilton. The changes become effective October 1st.

JOHN S. ROSS, who has been Oklahoma manager for Otis Pressure Control, Inc., making his headquarters at Oklahoma City, has resigned, his resignation taking effect September 1st. His future plans have not been announced.

J. H. MITCHELL, of the gasoline department, Tropical Oil Company, who has been at El Centro, Colombia,

J. H. MITCHELL

South America, for the last four years, has returned to the United States to remain permanently.

ALFRED G. WHITE, chief of the Petroleum Economics Division, United States Bureau of Mines, Washington, D. C., recently spent some time in Austin, Texas, attending the monthly hearing and looking over the records on Mid-Continent petroleum stocks, refined and crude, and their movement.

BYRON B. BOATRIGHT, until recently professor of petroleum engineering and head of the petroleum engineering department at the Colorado School of Mines, Golden, Colorado, is now associated with the firm of Parker, Foran & Knode, consulting petroleum engineers, with offices at Austin and Corpus Christi, Texas.

W. A. WARFORD has been appointed managing director of the British Sun Oil Company, Ltd., succeeding **ARTHUR STEVENS,** who resigned some time ago.

J. W. PAUSON, of San Francisco, California, has been made president of Italo Petroleum Corporation to succeed **JOSEPH SEELEY,** deceased.

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LAUGH WITH BARNEY

Edited by BARNEY HORRIGAN

John and George, small sons of a Baptist minister, after listening to one of their father's sermons, decided that they must baptize their family of cats. The kittens made no objection. One by one they were put in a big tub of water.

But when it came to the mother cat, she rebelled — and fought — and scratched — until at last John remarked:

"Just sprinkle her, George, and let her go to hell."—*The Lufkin Line.*

* * *

Judge (to amateur yegg): "So they caught you with this bundle of silverware. Whom did you plunder?"

Yegg: "Two fraternity houses, your honor."

Judge (to sergeant): "Call up the downtown hotels and distribute this stuff."

* * *

Rastus' lawyer was informing him on the legal status of his matrimonial relationship and his chances for a divorce:

"Mistuh Johnson, I has discovered I can get you yo' divorce on the grounds that yo' marriage ain't legal on account of her father—he had no license to carry a gun."

* * *

Her Model Husband

Relief Agent: They tell me you have a model husband.

Woman: Yes—but he ain't no workin' model.

* * *

Judge: Why are you here?

Motorist: Driving too slow.

Judge: Too slow?

Motorist: Yes, Your Honor, the speed cop caught me.

* * *

Risking the perils of death, the valiant knight had rescued the fair maiden and, now, he was holding her in his arms.

"Listen, big boy!" she cried, "You're not holding me for ransom, are you?"

"Not me!" replied the knight. "Let Ransom get his own women."

* * *

She laughed when I sat down to play.

How did I know she was ticklish?—*Washington Dirge.*

* * *

They call them virgin pines, because they've never been axed.

He: May I have the last dance with you?

Footsore: You've had it.

* * *

"Do your daughters live at home?"

"My, no. They're not married yet."—*Annapolis Log.*

* * *

During the recent turmoil in Cuba, the United States Ambassador was having a conference with the president at the capitol when a messenger entered hastily, went up to the president, whispered something in his ear, and then dashed out. The president arose slowly, and with an apologetic look on his face, said: "Excuse me, sir, I'll send the new president in to finish our conversation."

* * *

"I draw the line at kissing,"
She said in accents fine;
But he was a football hero,
So he crossed the line.

* * *

Joe (reading death statistics): Say, Phil, do you know that every time I breathe a man dies?

Phil: Then why don't you use a mouth wash?

* * *

Little Boy: Papa, vat's a vacuum?

Second Dialectician: A vacuum is a void, Sammy.

Little Boy: I know, papa, but vat's the void mean?—*Chicago Phoenix.*

* * *

"Mm, but that popcorn has a heavenly smell!" she exclaimed as they drove past the stand.

"Hasn't it!" he agreed. "I'll drive a little closer."

* * *

Dinner: Waiter, how many calories are there in this soup?

Waiter: Ain't none, suh! Dis here's a clean place to eat.

* * *

"And do you know anything about religion?" queried the missionary.

"Well, we got a little taste of it when the last missionary was here," replied the cannibal chieftain.

* * *

A Slip of Memory

Parent: "My daughter tells me that you are a church member. What church do you belong to?"

Suitor: "Why — the — er — name some of them over."

The Age of Speed

"Those potatoes you sold me last week were pretty small when I got below the top layer," the housewife said coldly to the old farmer.

"I know, Ma'am," he said plaintively, "but that there's a thing I can't help. With that new-fangled fertilizer I'm usin', pertaters grow so fast that by the time I've dug up a basketful the top ones are twice as big as the bottom ones."

* * *

The house agent decided to be quite frank with his latest clients.

"Of course," he began, "this house has one or two drawbacks which I feel I must mention. It is bounded on the north by the gasworks, on the south by an India-rubber works, on the east by a vinegar factory, and on the west there is a glue-boiling establishment."

"Good heavens!" gasped the husband. "Fancy showing us such a place. What a neighborhood!"

"Quite so," replied the agent. "But there are advantages. The rent is cheap, and you can always tell which way the wind is blowing!"

* * *

Professor: "If I were to be flogged, what would that be?"

Class (in unison): "Corporal punishment."

Professor: "But if I were to be beheaded?"

Class (still in unison): "That would be capital."

* * *

Not So Dumb

"Why is your car painted blue on one side, and red on the other?"

"Its' a great scheme. You should hear the witnesses contradicting each other."—*Rice Owl.*

* * *

Ideal Juror

"Do you know anything about this case?" the juror was asked.

"No."

"Have you heard anything about it?"

"No."

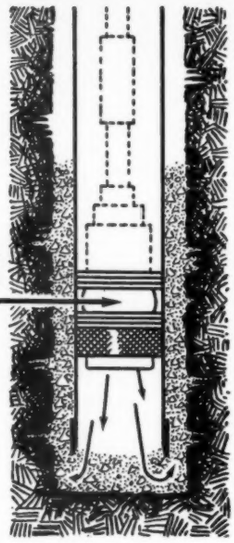
"Have you read anything about it?"

"No. I can't read."

"Have you formed any opinion about the case?"

"What case?"

"Accepted."—*Sun Dial.*



You can be SURE
of your SQUEEZE JOB when using the BAKER Model F CEMENT RETAINER

BY MULTIPLE BATCHES

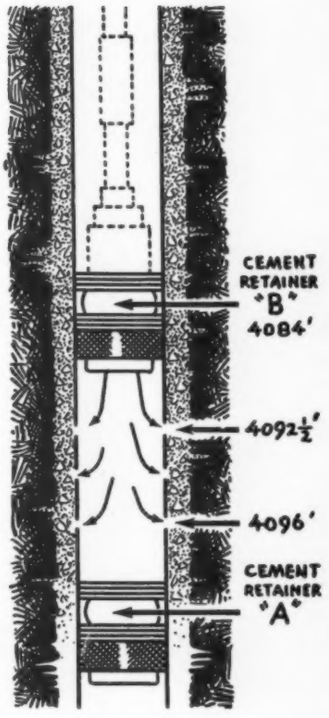
In the job shown above where the Cement Retainer "C" was set at 2226', thirteen feet above the shoe, 25 sacks were first pumped in. The pressure did not go high enough, so a second batch of 25 sacks was introduced, without changing the set-up. The Circulation Jar provided the means for doing this without contaminating or weakening the cement. The water pumped down between batches can always be passed out into the casing by opening the Circulation Jar and then closing the Jar when the following batch of cement reaches the Retainer. In this particular case, the Jar was opened and circulation reversed with the return of 8 sacks. This was done to check the amount of cement put away.

ALSO USED AS A CASING BRIDGE PLUG

The Baker Model F Cement Retainer can be set anywhere in liner or casing as a Bridge Plug. The setting operation is identical to the setting of the Cement Retainer except that a Bridging Ball is dropped down the run-in pipe. The Cement Retainer, as a Casing Bridge Plug, is being widely used alone for all types of bridging jobs, and in connection with the Cement Retainer for many kinds of cementing jobs.

AROUND THE SHOE

. . . when the cement must be forced into the formation or up around the pipe against any obstacles that may prevent circulation. Moreover, when using the Cement Retainer the pressure put on the cement stays there; a back-pressure valve acts automatically and eliminates the necessity for surface fittings to maintain the pressure. The tubing, Circulation Jar and Trip Mechanism are pulled and flushed out as soon as the job is finished. There is no danger of stuck or clogged pipe.



THRU PERFORATIONS

. . . by means of which squeeze jobs may be performed anywhere in the pipe, as illustrated to the right. The advantage of the Cement Retainer as a Casing Bridge Plug is also shown . . . The Cement Retainer "A" serving as a Bridge Plug was set below perforations at 4092.5'-4096' and the Cement Retainer "B" used for passing the cement was set at 4084'. Perforations had been made at 4041'-4044.5' but circulation could not be broken behind the pipe. So a squeeze job was done with 25 out of 50 sacks of cement being forced into the formations.

THE MODERN WAY OF CEMENTING

The Baker Model F Cement Retainer provides a means of placing cement under various difficult conditions. In addition to meeting problems requiring high pressures, it will successfully place cement in low pressure zones and, by means of the Cementing Ball, keep pressure off the cement. It thus allows the cement to stay around the pipe instead of being washed away by the hydrostatic head of fluid. You will be interested in Baker Broadcast No. 17 which gives many different applications. Send for free copy.

BAKER OIL TOOLS, INC.

POST OFFICE BOX 71, HUNTINGTON PARK, CALIFORNIA

COALINGA • TAFT • HOUSTON • OKLAHOMA CITY • TULSA • NEW YORK

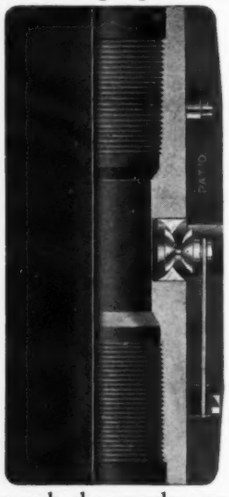
BAKER Model F CEMENT RETAINER

and Casing Bridge Plug

MACHINERY and EQUIPMENT

P & T Kick-Off Units

KICK-OFF units manufactured by Price-Trawick, Inc., Stroud, Oklahoma, are offered to the industry in three types: Internal, external, and standard two-way. The internal type is designed and recommended for small wells, those that do not have sufficient natural gas pressure to flow



them through the annular space. The standard two-way type permits the well to be kicked-off either through tubing or casing. The manufacturers state that the use of this unit in new wells eliminates the necessity of swabbing or bailing to displace rotary mud, water, or gas to get the well to flow. The external type unit will unload the well between the casing and tubing, with an average kick-off time of ten minutes, it is stated. The makers recommend its use when taking potentials, and state it also will permit a well to flow through the tubing in the same manner as the standard two-way unit. It is said to be especially desirable for use in wells that have a very low working pressure, since no pressure is required to keep the valve closed when flowing through the tubing.

The P & T Kick-off Unit is designed in accordance with the gas-lift theory that most efficient use of lift gas or air, for flowing, is obtained when the gas or air is all introduced without restriction at the lower end of the flowing column and none introduced at points higher within the flowing column. This theory is based on utilization of energy produced by the simple expansion of gas.

A kick-off valve is necessary, with this efficient system, to start the flow without the use of excessive pressures and to obtain the benefits of easy starting of wells and low pressures of compressors, the manufacturers state.

The features of the P & T Kick-off Unit for this use are given as: 1—Positive leak-proof closing; 2—Positive removal of liquid load before closing; and 3—Positive opening of valve, whenever necessary to again start the well.

"Oilwell" Sehon Snap-Up Sucker Rod Wrench

BY substituting a snapping or hammering action for main force, the new "Oilwell" Sehon Snap-Up Sucker Rod Wrench facilitates making up tight-fitting joints with maximum speed, minimum effort, and definite assurance that all joints are properly shouldered, the manufacturers state.

When sucker rods part because of pin fractures, the trouble can usually be traced to failure to properly shoulder the joints. Even the best rod crews sometimes fail to shoulder all joints with conventional wrenches, it is pointed out. When "Oilwell" Sehon Snap-Up Sucker Rod Wrenches are used, however, the snapping action so facilitates the work that crews find no difficulty in running rods with all joints properly shouldered, the makers claim.

The fast snapping action made possible by the patented construction of the "Oilwell" Sehon Sucker Rod Wrench greatly reduces the time required for making and breaking joints and thus appreciably speeds-up rod jobs, it is stated.

The head of the Sehon Snap-Up Sucker Rod Wrench is illustrated by Figs. "A" and "B". The head pivots on the heavy steel pin that is secured in the forked extension of the handle. The four-leaf steel spring, riveted to the back of the handle, tends to keep the handle and head in the relative positions shown in Fig. "A".

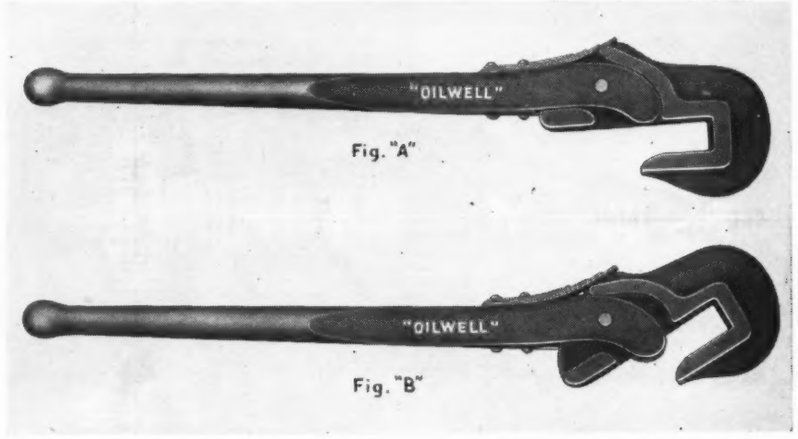


Fig. "A"

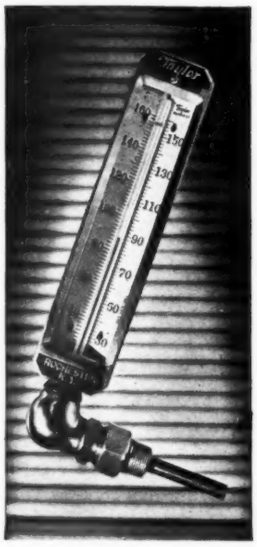
Fig. "B"

The wrench is used in the same manner as the conventional rod wrench except that the joints are shouldered and broken-out by a snapping or hammering action instead of by main force. Lugs on the head take the blows of the handle (see Fig. "A") so that no strain is placed on the pin on which the head pivots. The opening in the head is shaped to fit the wrench square snugly and is of ample depth to stay on the square while spinning the joint, the makers state.

Science Improves Readability of Thermometers

MERCURY-IN-GLASS industrial thermometers always have been somewhat difficult to read except at very close range and under most favorable lighting conditions. That characteristic not only discouraged frequent readings, but was responsible for many erroneous readings as well. The Taylor Instrument Companies, Rochester, New York, claim to have corrected this difficulty in a fundamental manner by a uniquely designed thermometer tube that is extremely easy to read.

This new thermometer tubing, known as Binoc, is described as an outstanding achievement of modern op-



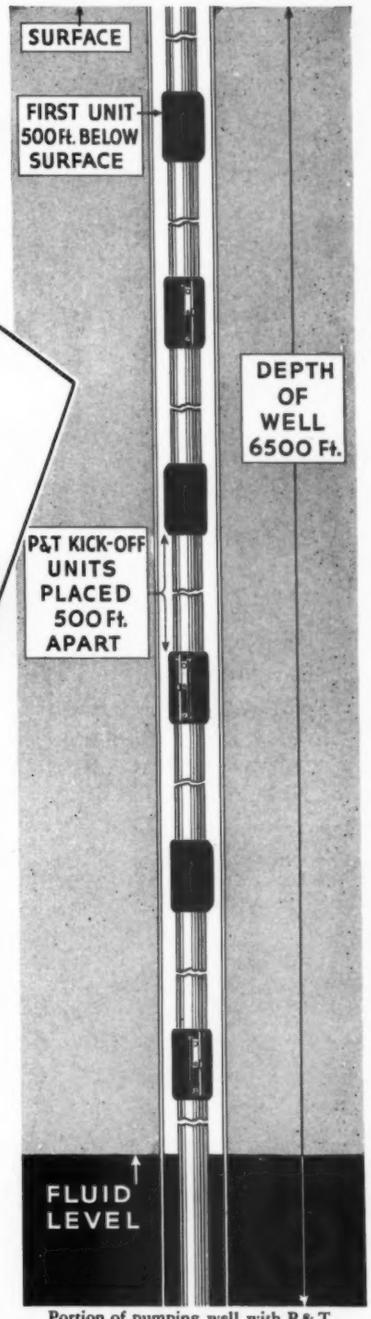
tical science. Advantages of the design are stated by the makers to be: More than twice the accustomed angle of vision combined with high magnification of the mercury column. Binocular vision (i. e., readability with both eyes) at normal or greater than normal distances; whereas it previously was necessary to stoop and squint. Triple-lens construction gathers three times as much light and concentrates it behind the mercury column, making the column stand out in sharp relief. Confusing empty-bore reflections are eliminated by the scientifically determined lens angle and extended opaque background.

The legibility of these new Taylor industrial thermometers is further improved by the bold, black numerals and graduations on the cream-tinted, non-tarnishing scale, it is stated.

The Taylor line of thermometers of this type is available in all the popular straight, angle, and handled forms.

Write for Bulletin 99023, which describes this new development.

A PRACTICAL and EASY WAY TO PUMP WELLS with P•T KICK-OFF UNITS



Portion of pumping well with P & T Kick-Off Units spaced 500 feet apart

This illustration shows the proper spacing of the P & T one-way Internal Type Kick-Off units on a pumping well.

With these units wells may be pumped more economically — a big portion of the load is taken off the rods and pumping equipment—the formation gas is utilized and saved—and gas locking conditions eliminated.

Write for new bulletin which gives complete explanation for use of all three types of P&T Kick-Off Units.

FOR BRINGING IN NEW WELLS USE OUR STANDARD TWO-WAY KICK-OFF UNIT OR OUR EXTERNAL TYPE UNIT

Price-Trawick Inc.

Manufacturers of P & T Kick-Off Units

P. O. BOX 295 STROUD, OKLA. TEL. 101 and 63

P & T Kick-Off Units STOCKED AT: Oklahoma City, 1111 S. E. 29th Street, Tel. 7-1761; Kilgore, Texas, 219 South Commerce, Tel. 179. California Representative: Geo. D. Hopkins, 390 Mira Mar Avenue, Long Beach, California, Tel. 874-84.

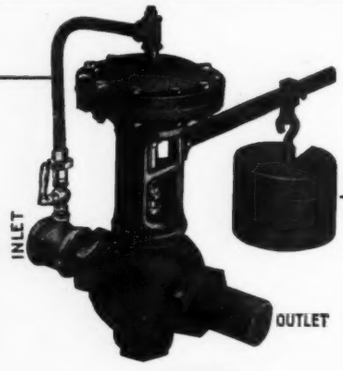
Oil Refinery Valves Hard-Faced

VALVES, the heart of refinery control, must be made of the most wear- and corrosion-resistant materials available if they are to give satisfactory service. The welding operator shown here is applying Haynes Stellite, a hard-facing alloy of cobalt, chromium, and tungsten, to the seating surface of a valve for refinery work. This is a standard operation in the production line of many valve manufacturers, since valves for either hot oil or high-temperature steam, whose seating surfaces are protected from corrosion, heat, and wear, last from six to ten times as long as unprotected valves, according to the Haynes Stellite Company.

Foam-Making Water Nozzle

A NEW method, mechanical rather than chemical, of making foam for fighting inflammable liquid fires and suitable for use with long or short lines of ¾-in. to 2½-in. hose has been announced by the Pyrene Manufacturing Company, Newark, N. J.

A water stream is converted into a continuous foam stream by coupling a patented nozzle, known as the Phom-



CF

Compressor Regulator

Speed Pump Regulation Made Definite and Sure

EXCESS discharge pressure is relieved, discharge kept constant, and operation of the compressor at full speed made safe, by use of the C-F Compressor Regulator. As a close regulator of pressure on electric-driven pumps, it stands unrivalled. Gas, steam, air, water—in all such applications the C-F Compressor Regulator is thoroughly dependable. The lever type is here shown. A spring loaded valve is also available and is equally sure in operation. Excess discharge pressure flows through without noticeable variation in suction line. Ask for Catalog of Chaplin-Fulton regulators for all requirements of gas-pressure control.

THE CHAPLIN-FULTON MFG. COMPANY

28-40 Penn Avenue Pittsburgh, Pa.

Business Men Prefer The TEXAS STATE *in Houston*

1. Because it is the most accessible and centrally located hotel in Houston.
2. Because it is Houston's newest, most modern, most comfortable hotel. (400 ROOMS—SHOWERS, TUBS)
3. Because its AIR-COOLED GRILL and DINING ROOM serve the BEST FOOD at the LOWEST PRICES.

The
TEXAS STATE HOTEL
400 ROOMS 400 BATHS
HOUSTON, TEXAS

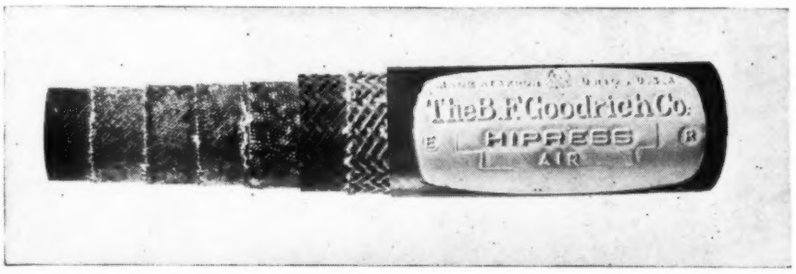
aire Play Pipe, to a water line supplying 75 lb. or more pressure at the play pipe. As the water passes through the play pipe, Phomaide, a new foam-making solution carried by the operator in a hip pack, and air are automatically drawn into the water stream in the proper proportions to form foam. Water may be pumped from suction, hydrant, or water tank. About 20 gal. of water per minute are required.

One gallon of Phomaide Solution makes 350 gal. of foam. Foam production of 300 to 400 gal. per minute may be continued indefinitely by merely pouring additional solution into the hip pack, it is stated.

In addition to the foam stream for fighting inflammable liquid fires a water stream for extinguishing any lingering fire in ordinary combustibles may be discharged by simply lifting the pick-up tube out of the solution. When it is again dropped into the solution a foam stream is produced.

New Type Air Hose Features Combination Construction

HIPRESS air hose, a new product designed for all types of air tool applications, has been announced by

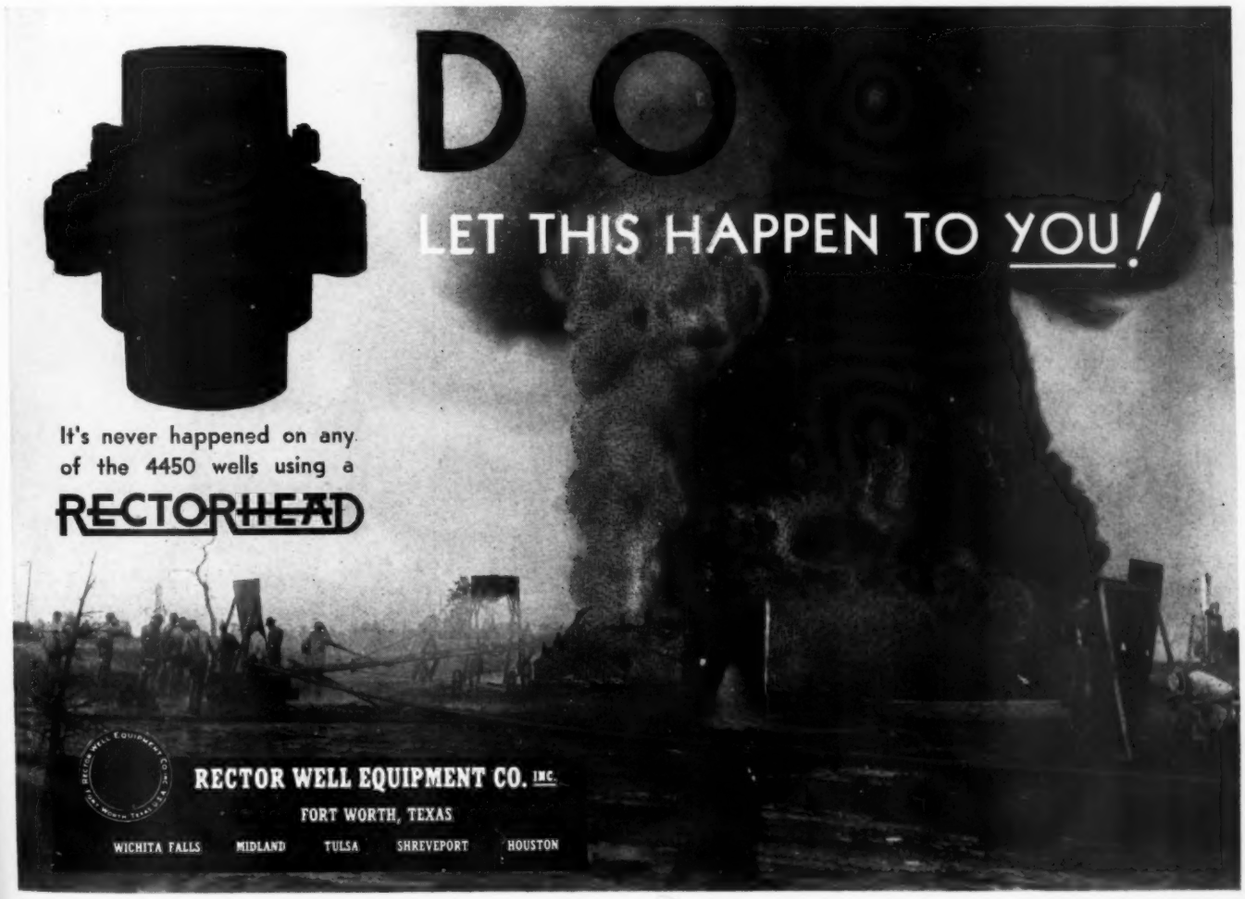


The B. F. Goodrich Company, Akron, Ohio. The manufacturers state that this hose is unique in that it is a combination construction made in long lengths. The inner carcass consists of four plies of specially woven duck. The outer carcass is a tight braid of high tensile cords that are applied with a tension ten times that normally used on long length braided hose. Between the inner and outer carcass is a substantial insulation that serves as a secondary tube to seal off penetration of air through the walls of the hose and to cushion blows from the outside.

The wrapped construction of the inner carcass provides an ideal backing for the tube due to the fine weave of the fabric. This is particularly valuable when tube is subjected to softening from internal heat. Due to the bias design of the wrapped fabric, any air or fluid that reaches it travels only a short distance before reaching terminal point of the yarn, thus preventing penetration throughout entire length of hose. However, the use of an outer braided carcass gives greater flexibility and more secure adhesion of cover than is obtainable with an all-wrapped construction.

The tube is made of special rubber capable of resisting both oil and heat. Not only is it claimed by the makers that this tube will last longer in air hose service where oil is present, but that it will not break into loose particles and clog the tools. The rubber cover of hose is compounded to withstand abrasion and abuse.

Hipress air hose is supplied in three sizes: ½ in., ¾ in., and 1 in., and is made in 500 ft. lengths.



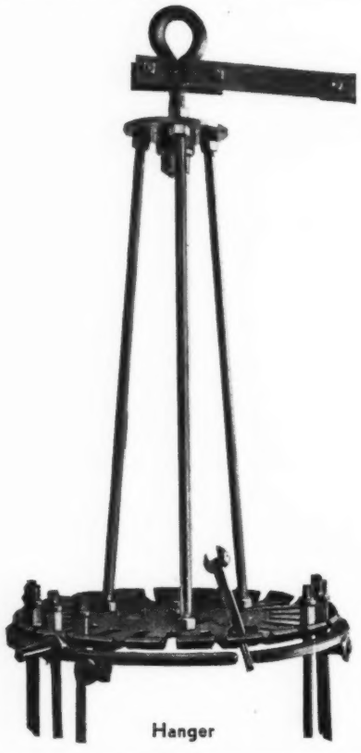
Axelson Safety Sucker Rod Elevator and Hanger

The two principal problems to be solved in the successful design of a sucker rod hanger for modern deep wells are the correct structural capacity and the safety features. After a prolonged study and actual tests in the field, the Axelson Manufacturing Company of Los Angeles, California, is distributing a safety hanger that the makers say not only will rack approximately 6000 ft. of rods weighing from 7000 to 1400 lb., but also will do it with absolute safety, and with great speed.

Swiveled on Timken roller bearings, the hanger is easily revolved to alignment with the elevator and the rods are slipped into the slots and locked by the safety ring. This ring locks all 22 slots simultaneously and cannot be accidentally disturbed after it has been set by the rod wrench. Accidental disengagement of the rods is impossible, it is stated. Convenience and speed are obtained by the ease with which the hanger can be revolved to face the elevator, and safety results from the fact that the rods are locked in before they are released from the elevator.

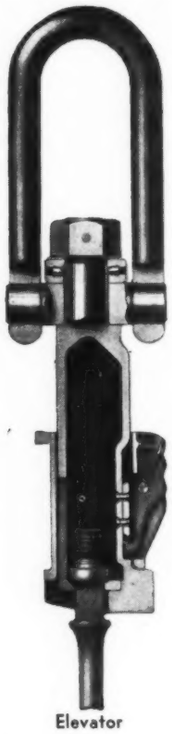
Ample anchorage to the derrick is provided, and all parts supporting weight are made of special steel.

Personal injury in handling sucker rods, and damage to rods, tubing, and other derrick equipment are eliminated by the improved design of the Axelson Safety Sucker Rod Elevator, the manufacturers state. These benefits are obtained without loss of time or efficiency in working conditions, and result from studies of actual operations.



Hanger

These elevators are proportioned to handle operating loads in the deepest wells with a high factor of safety, and all structural parts that support weight are made from special alloy steel correctly heat-treated and machined. A double swivel with Timken roller bearings gives responsive handling and makes the elevator hang freely and vertically at all times. The characteristic feature is a latched sleeve that must be raised to admit the rod and lowered to lock it in place. These operations are manual, and when the sleeve is in the locked position there is no possibility of a string of rods being disengaged or dropping out, it is stated. Instead of hanging on the tapered portion of the rod below the wrench square, the rods are engaged on the wrench square, preventing wedging and injury. When running in a string of rods, the operator on the floor locks the sleeve in the open position ready for the derrick man to pick up a string, after which the sleeve is locked in the closed position. When rods are being pulled, the operation is reversed. In either case, no time is lost and there are no hazards of damage or injury, even if the block swings and catches on the beam, the makers say. The elevator cannot turn over if the suspended weight is suddenly released.



Elevator

"Do you furnish the nails?"

. . . . . A Customer Writes

High Pressure Type for Slush Pumps

And the answer is: We would if doing so would help the user. But he'd just as well use nails out of the tool box, or pull one out of the bunk-house wall, if nails are scarce. The point we're making is that these are not special nails . . . just common wire nails from any carpenter's stock. That's one of the numerous reasons the **SHEAR-RELIEF** Valve is the simplest thing for the purpose on the market.

Use directions on the name plate to set the valve. The table gives pressures for each nail size, and the gauge checks the size for you. If pump pressure against the valve piston reaches the set point the nail shears, the piston travels out of the path of released fluid, and no damage is done except to the sheared nail. You merely re-set the valve with another nail.

Low Pressure Type for Small Pumps

FLUID-PISTON SLUSH PUMPS

ABERCROMBIE PUMP CO.

GULF BLDG. HOUSTON TEX.

Unit Pumper of National

ACCORDING to the manufacturers, all the generally recognized benefits of twin crank pumper design are available for comparatively light wells, at low first cost, in the new Type THD200G National Unit Pumper recently introduced by The National Supply Company, Toledo, Ohio. Economy in price has been obtained by increased compactness and the use of plain cranks and beam counterweight equipment. The assemblies that are particularly essential to long life are identical with the largest National Unit Pumpers.

Especially noteworthy in this respect is the effective distribution of loads and stresses, made possible by symmetrical construction. Having as a foundation the spaced herringbone reduction gear with its characteristic uniformity of load, wear and deflection, the entire design is especially favorable to the maintenance of original alignment and long life, it is stated. Complete equalization of loads on pitmans, cranks, and bearings is further assured by the equalized pitman assembly in combination with the hinged pitman upper connections and the SKF self-aligning double roller bearings on the wrist pins.

Counterweights are made in two halves with handles for convenient handling. When clamped on the beam and bolted to the end plate, they make, in effect, a solid unit. The maximum counterweight effect at the maximum 36-in. polished rod stroke, with all regular weights in position, is 4550 pounds. A polished rod hanger of proven design very closely approximates straight lift, and when two bolts are removed it may be lifted aside by the rod hook to give ample space for well servicing. The alignment of well and unit is not disturbed nor is it necessary to disconnect the pitmans or change the position of the walking beam.

The THD200G National Unit Pumper carries a nominal rating of 10 hp. at 20 s.p.m. The overall gear ratio is 30.1 and the weight of the unit with regular equipment is 4300 pounds. Counterweights are made in two halves of 250 lb. each.

This picture shows you why . . .

MacCLATCHIE
"MONEY-SAVER"
PUMP LINERS
ARE BETTER

REPLACEABLE, HARDENED, GROUND STEEL LINERS
GLAND
Slides on the Liner and lasts indefinitely.
LINER
Hardened alloy steel, ground to a mirror-like finish and economically replaced when worn.
PACKING RUBBER
Highest grade, economically replaced when necessary.
Assembled Liner

THESE EXCLUSIVE FEATURES GIVE YOU THE MOST FOR YOUR MONEY!

LONGER LIFE—You can't judge quality by the high prices asked for some pump liners. MacClatchie "Money-Saver" Pump Liners are absolutely the highest quality and outwear brands that sell for two to three times as much money. On tests by oil companies they have outrun costly spun metal liners. The astonishingly low prices will please you.

SUPERIOR CONSTRUCTION—MacClatchie "Money-Saver" Pump Liners are made of special alloy seamless steel, hardened and ground to a mirror-like finish. This superior material gives a harder and smoother surface than can be obtained by any other method of manufacture. Lighter weight makes them cheaper to transport.

DETACHABLE GLANDS—MacClatchie "Money-Saver" Pump Liners are quickly and economically replaced when worn. The detachable gland is not subject to wear—consequently lasting indefinitely. It slips onto the liner instead of being screwed on to it.

SUPPLY HOUSES: You are losing good profits if you are not stocking and selling this fast-moving, highest quality, low priced liner.

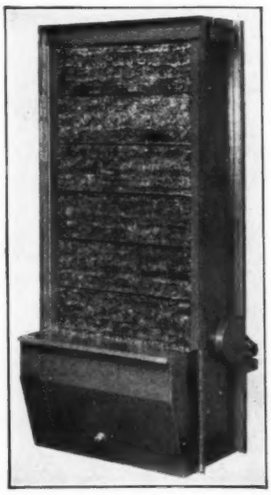
MacCLATCHIE
MANUFACTURING CO.
COMPTON, CALIF. HOUSTON, TEXAS
EXPORT: GEO. R. WOODS, 17 Battery Place, New York City

Automatic Impingement Type Air Filters

THE Staynew Filter Corporation, Rochester, New York, makers of Protectomotor products, announces the development of a new automatic impingement type filter. This new filter is designed to supply clean air for ventilating and air conditioning systems, as well as motors, generators, etc.

The operating principle of this filter is somewhat different from those already in use, it is stated, special attention having been given to the elimination of such defects as oil entrainment, difficulty of cleaning, etc. Oil entrainment often has been one of the most serious problems in past designs. In many instances it has been practically unavoidable where a high degree of air cleaning efficiency was required.

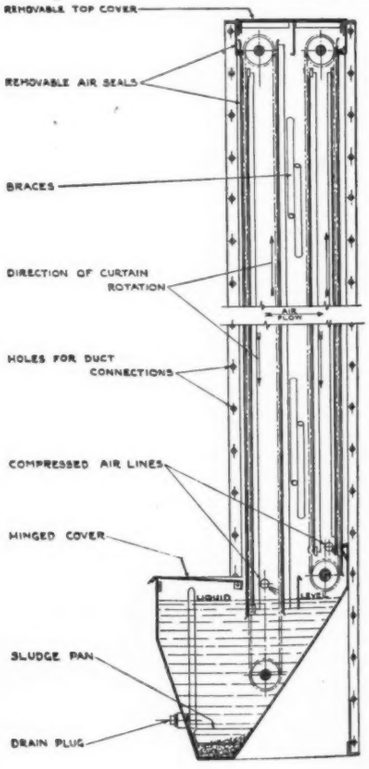
Realizing these facts, Staynew engineers have provided in this new Protectomotor filter *two* revolving curtains, thus giving a four-stage filtration. Ordinarily, in filters of this type, the direction of rotation is such that dust collected on the intake side is carried over to the outlet side before passing through the oil bath. In this new filter, dust collected on the intake side is removed by passing through the oil bath before the curtain that had been carrying the dust returns to the outlet side. Any oil entrainment from



the first curtain moistens the second curtain, which does not pass through the oil bath. The second curtain prevents all possible oil entrainment. Being slightly moist, it arrests any of the finer particles that may remain in the air.

A glance at the diagram and a study of the curtain rotation will show clearly in a most logical manner why the air leaving the filter will be clean and dry.

Extensive tests were made to determine the most adequate filter medium. One was required that would retain oil and provide an efficient method of



Are You Afraid of the TRUTH?

All of us are afraid to know the truth about some things. If fortune telling were an exact science instead of an interesting hoax, no man would dare go near a practitioner!

But there can be no menace in the truth about success in business. It means keeping income up and overhead down.

There are no "success" stories about men who used the right prime movers. But many a thrilling story is hidden away in ledgers.

We do not question a man's judgment because he does not use PURCHASED ELECTRIC POWER. We question his information. We challenge him to hear and analyze facts.

The key to the truth is simple: Call your Power Company before you install any prime mover for any oil country job. The Engineer who responds will be helpful. You will respect his knowledge and appreciate his co-operation.

Try it!

PURCHASED ELECTRIC POWER

PETROLEUM ELECTRIC POWER CLUB

breaking up the air stream so that the greatest number of dust particles would be arrested. Low resistance and imperviousness to corrosion also were necessary. The most efficient medium was found to be a specially woven, copper mesh. The formation of the loops assures a remarkable degree of oil retention and is largely responsible for the high cleaning efficiency of the filter.

Freedom from matted lint also is a feature. The copper mesh is attached to smooth wire screens that have no rough projections to which the lint could cling and build up resistance. The efficiency of the medium makes the use of sharp projections unnecessary, the makers state.

The filter is easily serviced from the front or rear. The panels can be removed from the curtain assembly with no other tool than a small screwdriver while the filter is actually operating, and at a convenient level to one standing before the filter. All other parts, including the drive mechanism, are reached easily. They can all be serviced without removing the top or parts that may be inaccessible after the filter installation is completed.

The driving mechanism is similar to other filters of this type. It is operated by a 1/6-hp. motor for only a few seconds every half-hour. Current consumption is practically negligible, it is said. The motor is actuated by automatic controls.

All filter sections are provided with a method for cleaning by compressed air. This is in the form of a copper tube drilled with a line of holes, mounted so that when air enters the tube from the user's air supply, it cleans the curtain effectively. This air cleaner is an exclusive Protectomotor feature, and a much needed improvement, according to the makers, for some positive method of cleaning the curtain from time to time is very desirable under conditions of heavy dust concentration. The air supply is controlled either by an electric valve connected with the timing device, or one manually operated.

Goulds Pump

DESIGNED for general service pumping where small space and low weight are essential, Goulds Figure

3620 motor-driven centrifugal pumps are available in standard and special constructions for the handling of ordinary and corrosive industrial liquids. Fifteen sizes meet all capacity requirements from five to 1600 gal. per minute. The combining of pump and motor in a single unit permits marked reductions in overall dimensions and weight without sacrificing strength or durability, the manufacturers state.

Substantial construction throughout and the mounting of all moving parts on a single oversized shaft, running in heavy-duty ball bearings to eliminate friction and wear, assure perfect alignment, eliminate vibration, and permit operation of the pump in any position, it is claimed. Impellers, carefully designed for high pumping efficiency, are of the enclosed single-suction type with safe motor load characteristics, mechanically and hydraulically balanced, and are securely keyed and locked to the shaft. The pumps are manufactured by Goulds Pumps, Inc., Seneca Falls, N. Y.

MORE THAN 100,000

UNIBOLT

ONE-BOLT COUPLINGS

in less than 4 years!

• • • • HERE'S THE REASON WHY: UNIBOLT represents the first real improvement in pipe connections since the conventional bolted flange union was conceived—hundreds of years ago. It is lighter in weight, easier and quicker to install, safer under high temperature and high pressure than other couplings, flange unions or connecting devices.

Briefly, the basic mechanical principle used in all UNIBOLT Couplings is as follows: Seal is accomplished through interlocking tapered shelves, one set of shelves being made integral with one hub of the coupling, another set being made integral with the nut or outer member of the coupling. A single bolt, which is under initial stress only, draws these self-locking shelves into position, applying tremendous pressure on the seat and seal ring. Pressure at all points is automatically equalized, regardless of any misalignment in the shelves.

Ask your supply dealer, or write direct for fully descriptive folder.

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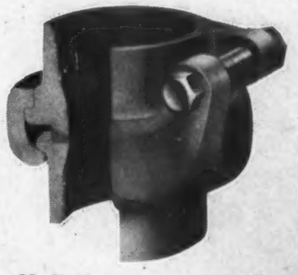
THORNHILL-CRAVER CO.

HOUSTON - TEXAS

High pressure steel UNIBOLT, with replaceable metal seal ring, 6000 pounds test.



Medium pressure malleable UNIBOLT, with replaceable resilient seat ring, 1000 pounds test.

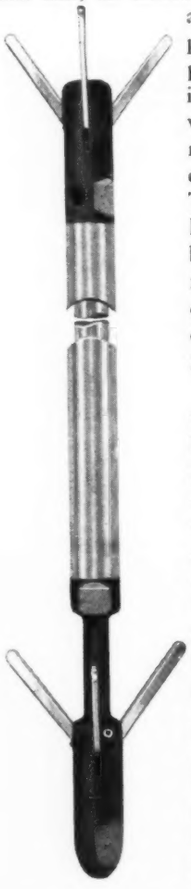
Steel UNIBOLT, with replaceable and reversible resilient seat ring, for 8" and 10" pipe, for use on pump suctions or pipe lines. 2000 pounds test. Available with blanking plug for compounding pumps or making dead-end lines.

Photographic Go-Devil

A NEW Photo-Record Go-Devil is now being supplied by Alexander Anderson, Inc., Fullerton, California, for measuring the inclination of drilling wells. This instrument is dropped into the drill pipe to land on a catcher inserted above the bit. It is enclosed in a 1½ in. O. D. watertight outer case, which is equipped with a new type of expansible fingers at its upper and lower ends. Cases 1¼ in. O. D. also are available for use in 3-in. drill pipe.

The fingers are made of tough, hardened steel, and will center the go-devil in any size drill pipe during its descent through the pipe; yet when the go-devil enters the drill collar the spring fingers will still center it even though the hole through the drill collar does not exceed 1¾ inches. An interesting feature of these fingers is that the pressure exerted by the fingers against the inside of the drill pipe remains the same no matter whether the drill pipe is small or large, and this feature removes all possibility of the go-devil hanging up in a small tool joint or in the drill collar.

The instrument itself is enclosed in a 1-in. O.D. stainless steel tube 28 in. in length that houses from top to bottom a clock, dry cells, a camera compartment with photo-record disc holder and lens, an electric light globe, and a plumb bob. The plumb bob is suspended from the intersection of two wires that are carried by a removable cylindrical sleeve. Three different lengths of plumb bobs are provided for measuring inclinations up to 4 deg., 10 deg., and 26 degrees.



The clock is set by turning a knurled head near the upper end of the instrument and is wound by means of a separate key. The clock is set at the time interval required for the instrument to reach position in the well, and by closing a light switch at that time illuminates the compass and plumb bob to make a photographic record of inclination. The photographic exposure has a duration of only one-half minute.

The 1½-inch O. D. outer case is ¼-in. wall thickness and provides robust protection for the instrument. The instrument is carried between rubber cushions at top and bottom. All instruments are tested by dropping them a clear distance of 15 ft. onto a metal plate. Experience has proved that an instrument subjected to repeated dropping from such a height cannot be damaged by normal rough treatment in an oil well.

The instrument is loaded with preprinted record discs from a daylight loading magazine. After the reading is taken and the instrument removed from the outer case the exposed disc is developed and fixed in about four minutes. When the disc is developed, an image of the plumb bob cross-hairs and preprinted degree circles appear on the face of the disc, all in clear sharp cutlines. The inclination is read directly from the position of the plumb bob cross-hairs with relation to the degree circles.

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EASY TO PROVE IT'S
THE MOST ECONOMICAL
ROTARY HOSE TO USE
GRIZZLY
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for Wear
Grizzly Powerflex Rotary Hose has a performance record that is truly remarkable. Used for drilling many of the world's deepest wells in the toughest fields, we never have had a blowout or hose failure even under the hardest drilling and extreme pressures. One Grizzly Powerflex setup is known to have served for drilling six different wells to completion, ranging in depth to 7500 feet and more. It is tough, flexible and blowout-proof. Ask your nearest Grizzly dealer.
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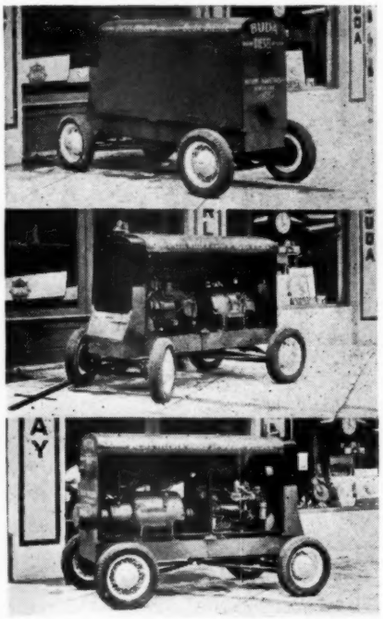
GRIZZLY
POWERFLEX
ROTARY HOSE

In operation, the kelly is removed and the go-devil dropped after setting the clock to the required interval for making the exposure. The kelly is reconnected and the drill pipe lowered until the bit is just above bottom. Circulation may be maintained and the pipe slowly rotated up to about a minute before the picture is taken. The advantage of the Photo-Record Go-Devil is that unless the plumb bob is at rest, the result will be a blurred image, which will render the reading of no value. A clear, sharp photo assures a true record of inclination. Mechanically operated go-devils will give a reading whether the plumb bob is at rest or in motion, the manufacturers state.

Portable Electric-Welding Unit, Diesel Driven

HIGGINS INDUSTRIES, Inc., New Orleans, Louisiana, has developed a new portable electric-welding unit driven by a Diesel engine.

The Diesel engine is manufactured by the Buda Company and known as



their model 4-D-186, 3⅝-in. bore, 4½-in. stroke, operating at 1500 r.p.m. It is direct connected, as shown on the accompanying illustration, by flexible coupling to a Westinghouse Flexarc welder having a capacity of 300 amp., fully controllable. The welder is, in turn, synchronized with a 115-volt, 8.7-amp. generator that provides ample illuminating power for field and night work.

The unit is protected with an oversize radiator for long and continuous operation. The fuel system is equipped with two heavy-duty filters. The fuel tank is built into the chassis on which the entire unit is mounted. In the framing a provision has been made so that the engine may be readily lifted from the base to permit cleaning and inspection of the oil reservoir and the oil screen. The exhaust is equipped with a dry muffler and exhaust noise is virtually eliminated.

The photograph shows (top view) how the entire unit, when not operating, is enclosed with sheet metal housing on all sides for complete protection from atmospheric conditions, sand, rain, etc.

Service and trouble lights are included in the accessories to the unit, being directly operated from the 115-volt generator. Tool and parts lockers also are built into the unit, as well as compartments for welder's shields, welding rods, and supplies.

This portable welding unit, under full load on exhaustive tests, has proven remarkably efficient, the manufacturers claim. Operating costs aggregate not more than 12 cents per hour, which includes complete change (2 gal.) of lubricating oil every 100 hours of operation, it is stated.

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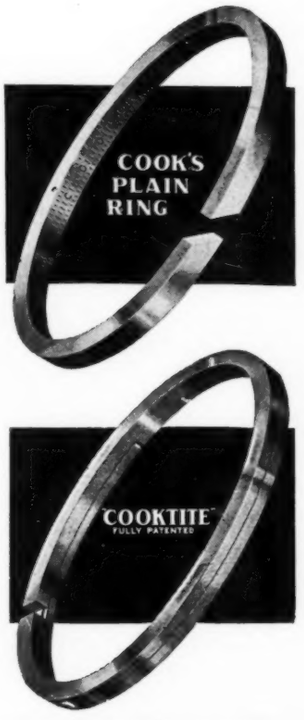
will do a better job
. . . *and they'll prove it!*



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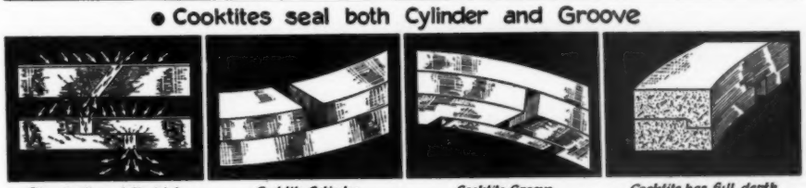

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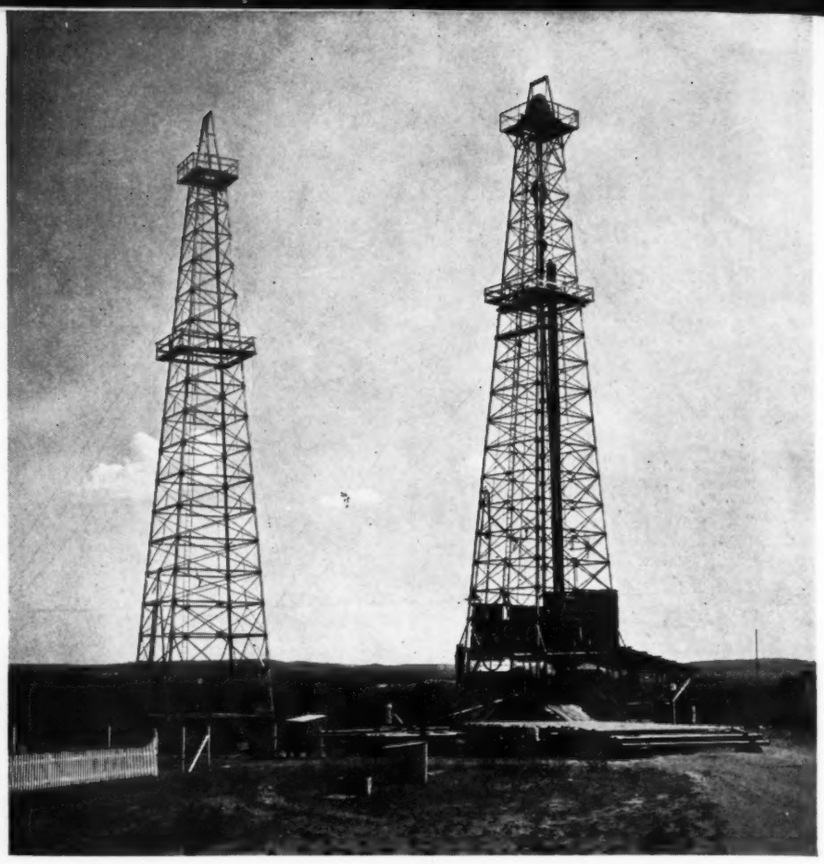


No. 7 George Smith of E. H. Moore, Inc., drilling for the Hunton lime. The other well in the photograph is producing from the Bromide formation

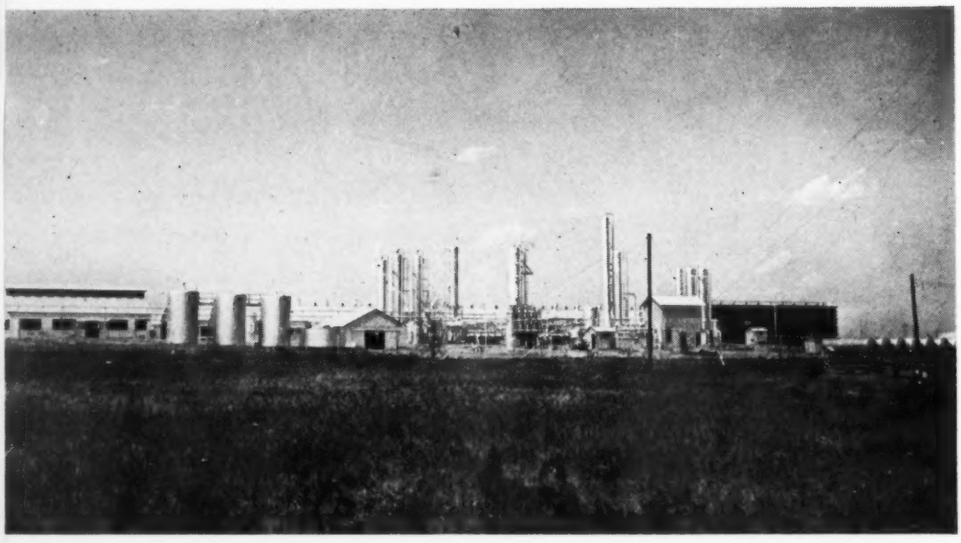
Fitts Pool Activity Continues on Anniversary

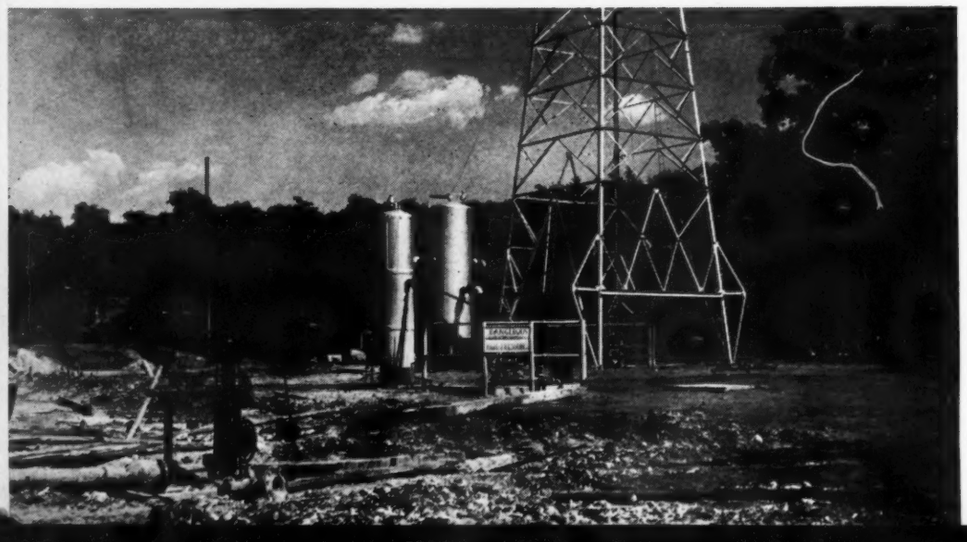
TWO years after the discovery of the Fitts Pool in Pontotoc County, Oklahoma, finds this prolific field still one of the major "hot spots" in Oklahoma. More wells are now drilling in this pool than in any other area of the state. Considerable drilling is being done to the third major producing horizon in the field—the Wilcox Sand—found only along the southern edge of the field.

This pool has been unusual in several respects. Given little or no possibilities before the first well was drilled in, it has proven to be the largest pool in the state since the discovery of the Oklahoma City field. Faults along the south and west sides definitely have defined those two sides of the pool. The east boundary is yet undetermined. The field often has been called a driller's paradise due to the abundant gas and water supply available. Big Spring Creek, running the entire length of the field, in addition to supplying the sizable town of Ada, has provided sufficient water for drilling.

In the Upper Simpson horizon more than 300 wells are now producing, having a potential of 893,410 barrels. Depth of these wells averages approximately 4000 feet. Many wells are now drilling and a few producing in the Hunton lime found at 3300 feet. Most Hunton wells are twin locations to the original Upper Simpson wells. Along the southern edge of the field 20 Wilcox wells, with a depth averaging approximately 4400 ft., had a July potential of 49,175 barrels. At least 50 more wells are now drilling with the Wilcox as their goal.

The initial bottom-hole pressure in the Upper Simpson was approximately 1850 pounds. After two years the average pressure for the field is 1350 pounds. Virtually all wells are still flowing naturally.





Top—Gasoline plant of the Carter Oil Company, Fitts Pool, Oklahoma. Gas is taken from 80 percent of the wells in the field.

Bottom—Three wells of the J. E. Crosbie Company producing from different depths. The well in the foreground was completed in the Hunton lime, producing 200 bbl. an hour through the tubing

FIT FOR Any JOB!

McNEELY Vibrating Mud Screens are as efficient on the toughest jobs as on ordinary ones. For example, in the "Mansion Extension" of the Oklahoma City field, a McNEELY Vibrating Mud Screen satisfactorily handled the entire output of 15 x 7¾ x 20 slush pumps—the largest pumps used in this field.

If it's best results you want—use McNEELY Vibrating Mud Screens. Records in the field prove their superiority!

McNEELY Vibrating Mud Screen in the "Mansion Extension" of the Oklahoma City field.

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For Accuracy . . . Speed . . . Ease

in Measuring the Inclination of a Drilling Well

The Anderson
PHOTO-RECORD GO-DEVIL

The Go-Devil is dropped into the drill pipe to land on a catcher inserted above the bit.

This instrument, run in a water-tight Outer Case of only 1½" O.D., is furnished with *Interchangeable Inclination Units* for maximum of 4°, 10° and 26°. These units provide the largest reading scale possible for any condition encountered . . . with *Only One Instrument Required.*

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B-M-W Balls and Seats are obtainable at supply stores. For data on the principal B-M-W Products use the coupon below.

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Please send complete information on the following B-M-W Products without obligating us in any way:

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J. McC. Moffett Dies

It is with great sorrow that the Midwest Piping and Supply Company, Inc., St. Louis, Missouri, reports the death of J. McC. Moffett, who suffered a heart attack while working in his office September 5th. He served in the capacity of vice-president in charge of sales since the formation of Midwest in 1920, and had much to do with the success of that company.

Previous to the formation of Midwest he was vice-president of the Urbauer-Atwood Company, piping contractors, and prior to that was identified with the Chapman Valve Company, Kansas City Steel Railways, and the Standard Oil Company of Indiana.

Moffett was 64 years old and is survived by his widow, Myrtice, three daughters, Ileta, Martha, and Betty, all of Webster Groves, Missouri; also a sister, Mrs. Evelyn Strain, of Lexington, Virginia.

E. L. Stevens Joins Union Wire Rope

E. L. Stevens, widely known to a host of friends in the oil country as "Steve," joined the sales staff of the Union Wire Rope Corporation in August as sales manager of the company's commercial department. This department handles sales to the logging industry, the building and construction field, and for general industrial purposes.

Stevens has had extensive experience in the wire rope industry, having been with the Wickwire Spencer Steel Company for a number of years and later

E. L. STEVENS

having served with the Republic Supply Company in connection with sales of Edwards Wire Rope. His headquarters will be at the company's general offices and factory, 21st and Manchester, Kansas City, Missouri.

Hilliard to Cover Kansas For Byron Jackson

Ben Hilliard, who for a considerable time has been in the sales department for BJ, recently was assigned to cover the Kansas oil country for Byron Jackson Company. Already widely known throughout the Mid-Continent, Hilliard can be reached by his many friends at Wichita, Kansas.

BEN HILLIARD

Latest developments in PRESSURE DRILLING!

Operators drilling with oil under pressure find that Chiksan All Steel Rotary Hose is indispensable because it is *unaffected by oil.*

When using the "Pressure Drilling" method don't take chances with hose that oil deteriorates. Play safe! Rely on the *positive safety factor* of Chiksan Hose. Safeguard your workmen and your well with this Safe, Flexible, Economical equipment.

Chiksan All Steel Rotary Hose is available in 2", 3" and 4" sizes. Write for New Rotary Hose Folder!

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PACIFIC NORTHWEST DISTRIBUTOR — E. C. GRIFFIN [illegible] AVE. NORTH, SEATTLE, WASH.

Smith Separator Adds to Personnel

Smith Separator Company, Tulsa, Oklahoma, announces two important additions to its personnel. C. M. Rader, for four years division engineer and assistant division superintendent of production for Phillips Petroleum Company, becomes special sales engineer, and A. P. Francis, for seven years with the Stockham Pipe and Fitting Company, Birmingham, Alabama, assumes the position of designing engineer. Rader is a graduate of University of Minnesota. Francis, an Alabama University graduate, formerly was with Westinghouse.

C. M. RADER

Rader has a background of 20 years' engineering experience. He was five years with Mid-West Refining Company out of Casper, Wyoming; four years with I.T.I.O. Company, and four years with Phillips Petroleum Company, serving these companies variously as resident engineer, production engineer, division superintendent, and assistant to the vice-president in charge of production.

John Gribbel Passes Away

John Gribbel, banker, manufacturer, and civic leader, who for 53 years was prominently identified with the gas industry, died at his summer home "Weatherend" at Camden, Maine, August 26.

Gribbel, who was 78, had given up the post of president of American Meter Company last May, to become chairman of the board. Last January he also retired as president of the Tampa Gas Company, a position held since 1911, to become chairman of the board.

Although well known in the gas industry throughout his life, Gribbel was prominent in many other activities.

Born March 29, 1858, in Hudson City, now a part of Jersey City, N. J., Gribbel was educated at the College of the City of New York. Following an early experience in banking, he entered the firm of Harris Griffin and Company, gas meter manufacturers, in 1883, and soon became the directing head. Later he entered the succeeding firm, John J. Griffin & Co., and in 1892, when Mr. Griffin died, Gribbel bought out his interests and continued as the head of the business that later combined with other units incorporating in 1895 as American Meter Company. At the time of his death, Mr. Gribbel was a director of nearly a score of companies.

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that hundreds of Sievers Reamers are being used today—used by drilling contractors who get paid by the foot or for a turn-key job and don't want any tool down the hole unless it pays dividends each round trip—used by major operators who insist upon low-cost vertical, full-gauge hole—used by others who make every penny count.

One by one, during the years, they have proved to their complete satisfaction that . . .

1. **The slicing, shearing action of a Sievers Reamer is the *rapid* reaming method;**
2. **The contact of a Sievers Reamer with formation (almost 50% of the circumference of the hole) is a *new standard for stabilizing a drilling bit;***
3. **The 4-Way Locking Device on Sievers Reamers makes it practically impossible to lose parts;**
4. **The exclusive, patented design of a Sievers Reamer directs force downward and does not slow up drilling speed;**
5. **The results, measured by fast, safe full-gauge hole, are worth far more than the amount expended.**

Proved by years of successful service, you will be taking no chances with a Sievers Reamer. But, you'll never REALLY KNOW until you run one. Why not get in touch with our nearest office or distributor and start to "Save with Sievers"?

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OKLAHOMA & KANSAS DISTRIBUTOR: CARSON MACHINE & SUPPLY CO.

Fred E. Cooper Opens West Coast Branch

Fred E. Cooper, the exclusive oil field representative of the Allis-Chalmers tractor division—well-servicing equipment—has opened a new West Coast branch at 9619 South Main Street, Los Angeles, California.

The branch will carry a representative line of Allis-Chalmers well-servicing equipment, winch tractors, skid winches and multiple-cylinder engine power units. A service and parts department also will be maintained.

The new plant will be under the direction of H. R. Moon, who for the past year has been sales representative for Fred E. Cooper in California.

With the opening of this new branch, which will specialize in well-servicing equipment for the oil fields, the Allis-Chalmers Manufacturing Company will have representation in California of all its divisions.

O. D. Donnell Heads Findlay's Golden Celebration

The trustees of Findlay's Golden Celebration of Gas and Oil, Inc., announce the election of O. D. Donnell, president of The Ohio Oil Company, Findlay, Ohio, as president of its organization.

Findlay's Golden Celebration of Oil and Gas is scheduled for June, 1937, and will mark the 50th anniversary of a celebration held in Findlay at the peak of the tremendous gas boom.

O. D. DONNELL

The celebration planned for June, 1937, will extend over the entire week of June 20th, and will feature a pageant, in which a thousand people will perform, an air circus, sport's pageant, parades, etc.

Due to the fact that many former residents of Findlay are now associated in the oil and gas industry, plans are being made to suitably entertain large delegations from almost every known oil field, and the entire celebration will, in effect, be something of a home-coming for these former citizens, who will be greeted by a well-balanced and comprehensive program, rapidly assuming form under the leadership of Mr. Donnell.

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Understanding

That's the simple rule that accounts for the close relationship between the National Bank of Tulsa and the Oil Industry.

Because of this understanding, Oil Men know that the Oil Bank of America is the place to go when they need money.

The officers of the bank know that good oil loans make first class investments for their depositors' funds, so they want all they can get.

This mutual confidence makes good business for both parties interested.

The Oil Bank of America

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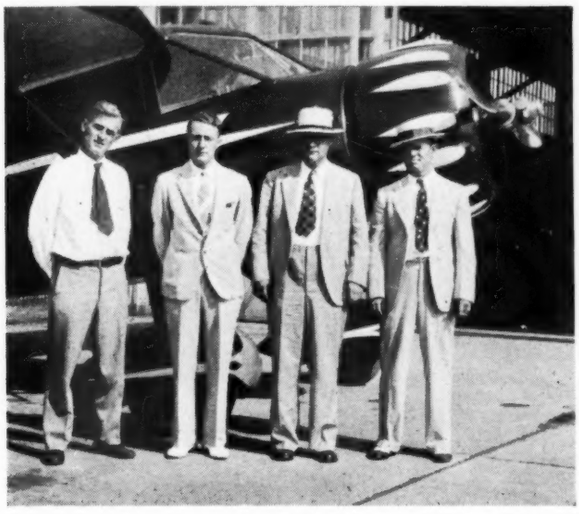
T. N. St. Hill on Trip

T. N. St. Hill, vice-president of Petroleum Rectifying Company of California, left Los Angeles by plane recently on one of his numerous flying trips to Gulf Coast, Mid-Continent, and eastern oil fields on company business. He planned to spend several days at the company's branch office in Houston, Texas, en route, returning to his office at Los Angeles in about ten days or two weeks.

South Central Drilling Company Organized

The South Central Drilling Company has been incorporated in California and licensed to do business in both Texas and Louisiana for the purpose of contract drilling in Mid-Continent fields.

This company is closely identified with Taft Well Drilling Company, Bakersfield, California, the officers and directors being identical, and is a closed corporation. B. H. Dye is vice-president and manager, and the southern office is at 539 Ricou-Brewster Building, Shreveport, Louisiana. T. M. Gavin, assistant-secretary, will have charge of the office and legal and accounting departments. W. F. Buaas is president, and F. L. Shepherd secretary and treasurer.



Left to Right—T. M. Gavin, assistant secretary; F. L. Shepherd, secretary-treasurer; W. F. Buaas, president, and B. H. Dye, vice-president

Transport Oil Tool Company New Concern

The Transport Oil Tool Company has been organized and will be under the management of L. B. MacGregor, it is announced. Headquarters will be maintained at 905 Obispo Avenue, Long Beach, California. The company will serve as factory representatives for a number of oil tool manufacturing concerns in California and the Mid-Continent as well as in foreign fields. MacGregor is well known in the oil industry, having been associated as sales engineer with various firms in California. He has just completed a tour of Texas and Oklahoma.

L. B. MacGREGOR

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RIDGID WRENCH STRENGTH AND PERFORMANCE ARE UNBEATABLE

With its all-over oil hardened chrome molybdenum alloy jaws and new alloy housing and handle, this RIDGID meets all Government and U. S. Navy tests. Housing is guaranteed unbreakable. You'll like the adjusting nut in open housing that spins easily in all sizes 6" to 60". And it's made in End Pattern for pipes against flat surfaces. Try it — and you'll understand its popularity.

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If this Housing ever Breaks or Distorts We will replace it Free
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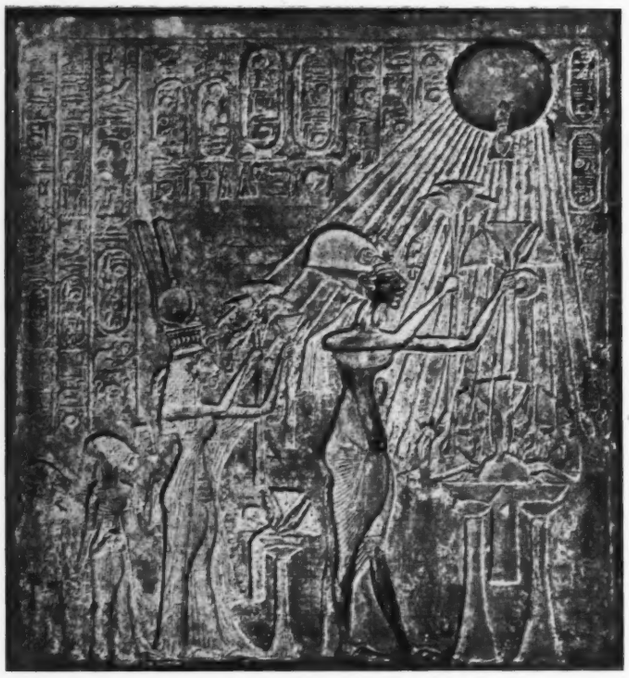
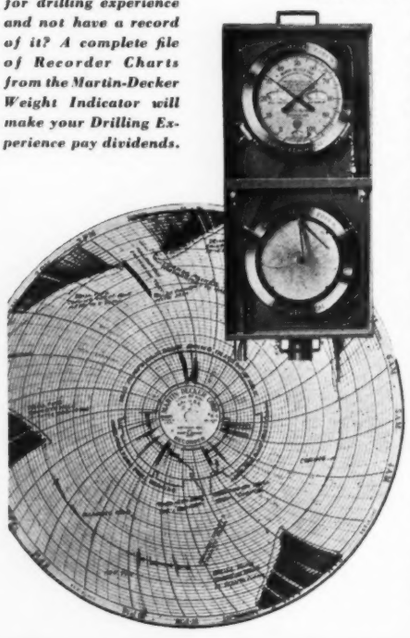


A

Written RECORD,

BASIS FOR ALL PROGRESS

Can you afford to pay for drilling experience and not have a record of it? A complete file of Recorder Charts from the Martin-Decker Weight Indicator will make your Drilling Experience pay dividends.



Prehistoric man learned that the gleanings of his experiences were too valuable to be trusted to memory so he made records of them in stone, and the recording of man's experience has been the basis of the progress of civilization.

Written records are equally vital to advancement and economy in oil production. A complete record of the well you are drilling is your only real guide for the next one you drill.

With twist-offs, broken lines, crooked holes and drill stem failures ever present dangers, the driller of an oil well needs every aid to safe and sound drilling practice. A recorder on the Weight Indicator gives accurate, complete information on drilling weights at all times and provides a guide to better drilling each succeeding day.

The permanent chart provides a graphic record of operations which, when placed side by side with geologic data for comparison, brings out information of surprising value.

THE WEIGHT INDICATOR

MARTIN DECKER CORP.

LONG BEACH CALIFORNIA

San Joaquin Valley: A. F. McQUISTON, Oildale, California

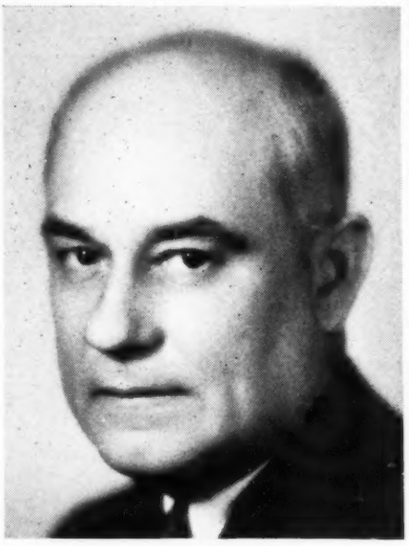
Mid-Continent Distributor: REED ROLLER BIT COMPANY, Houston, Texas

Change in Executive Personnel A. O. Smith Corporation

L. R. SMITH

At a recent meeting of the board of directors of the A. O. Smith Corporation several major changes were made in the executive personnel of the corporation. L. R. Smith was elected to the office of chairman of the board. W. C. Heath was elected president, and J. M. Floyd, vice-president in charge of manufacture and engineering.

The recent expansion of the corporation into new lines of activity has required an increase in the engineering and research staffs, and the foregoing changes in the executive positions meet these demands.



W. C. HEATH

Heath, formerly with the Fairbanks, Morse & Company, became vice-president in charge of manufacture and engineering and a director of the A. O. Smith Corporation in November, 1931. His election at this time to the presidency puts him in complete charge of the corporation's organization and its operations.

Floyd, who assumes Heath's former position as vice-president in charge of manufacture and engineering, has been connected with the Bendix Corporation of South Bend, Indiana, for a great many years, and comes to the A. O. Smith Corporation with a wealth of experience in the production field.

The other officers of the corporation are R. F. Bell, vice-president, C. C. Joys, Jr., vice-president and director of sales, and J. J. Stamm, secretary and treasurer.

HOLT McWORKMAN has been appointed district manager in charge of the Oklahoma territory for The S. M. Jones Company. McWorkman has been connected with The S. M. Jones Company for a number of years, having had thorough field experience in West Texas with both sucker rods and pumping conditions. The Jones company also announces the appointment of **W. F. SLATER** as district sales representative covering the Tulsa territory. The Tulsa district headquarters of the company will continue its location at 715 McBirney Building, Tulsa.

Trade Personals

ARCH F. CAMPBELL, Tulsa representative of the Waukesha Motor Company, is making a business trip through Colorado, Wyoming, and Montana oil fields.

PETE WALLACE, manager of Link-Belt Company's oil field division, returned to Houston recently, following a two-month's trip through California and the Rocky Mountain fields, covering West Texas fields en route to the West Coast, and the Mid-Continent territory on his return.

WILLIAM HOGENSON, JR., has been named special representative on Toncan Iron enameling stock, according to an announcement by **F. H. RAMAGE,** manager of sales promotion, Republic Steel Corporation. His work will be in conjunction with that department under the new product development division.

HOYLE JONES has been appointed district sales manager with headquarters in Tulsa, Oklahoma, according to an announcement by **N. J. CLARKE,** vice-president in charge of sales of Republic Steel Corporation. This appointment fills the vacancy caused by the recent death of **C. S. POWERS,** former district manager.

J. S. WARREN, general manager of the Maloney Tank Manufacturing Company, of Tulsa, Oklahoma, left the city recently with Mrs. Warren for an automobile tour into the Rocky Mountain and Canadian oil areas. Mrs. Warren stopped at Manitou, Colorado, while Mr. Warren visited the Denver division headquarters of the National Supply Company, which is distributor for Maloney Tanks in the Rocky Mountain oil area, then went on to Casper and Cody, Wyoming, Kevis and Cut Bank, Montana, and Canada. The trip, which was a combined vacation and business trip, took three weeks.

LLOYD C. HARBERT, secretary-treasurer of Pacific Enterprises, Inc., for several weeks has been making a survey of conditions in the Mid-Continent and the Gulf Coast fields in the interest of his company. He was joined late in August in Dallas by **MAX HEBGEN,** vice-president of the company.

Heads Insulation Division for Eagle-Picher

Glen J. Christner, formerly in charge of The Eagle-Picher Lead Company's New York Insulation Division, recently was transferred to Cincinnati as manager of the entire Insulation Division.

GLEN J. CHRISTNER

Christner was graduated from The Missouri School of Mines in 1922. He was then associated with The American Bridge Company in Philadelphia until he joined The Ingersoll-Rand organization. Employed as a sales engineer with the latter company, he soon became manager of a sub-branch, was then assigned to Tokyo, Japan, for one year, finally being brought back and placed in charge of far eastern business.

This experience, plus that which he obtained while opening and developing the New York market for Eagle-Picher, makes him particularly well suited for his new position.

NEW WAY

to make better endless belts that

last longer, increase production, cut costs, reduce down time

Every oil man knows that endless belts reduce down time as much as 80%, increase production accordingly, outlast fastener-joined belts many times, save time and worry. But you don't use them because they take weeks to get.

Now You Can Get Endless Belts in Few Hours

Goodrich has perfected a new method—belts can be made endless on your drives or in the shop of your Goodrich Distributor in a few hours depending on size of belt. This is the Plylock Method—using a patented splice that will last longer and stand more punishment than any other splice or any factory-made endless belt.

Any mechanic can learn in an hour how to make the Plylock Splice. Only equipment needed is a few simple tools and a portable electric vulcanizer.

Plylock permanently protects the splice from wear and windage—*it will not open up.* With this new splice belts have lasted as much as 20 times longer than any previous belt of any make. Cut *your* down time—increase your production—reduce belt cost—banish fastener trouble and danger. Send for prices, complete data and location of nearest Goodrich Distributor with Plylock vulcanizing equipment.

THE B. F. GOODRICH COMPANY
Mechanical Rubber Goods Division, Akron, Ohio

MAIL THE COUPON NOW

THE B. F. GOODRICH COMPANY
500 Rubber Street, Akron, Ohio

Without obligation, send me prices and data on Plylock and address of nearest Distributor equipped to supply me.

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My name _____

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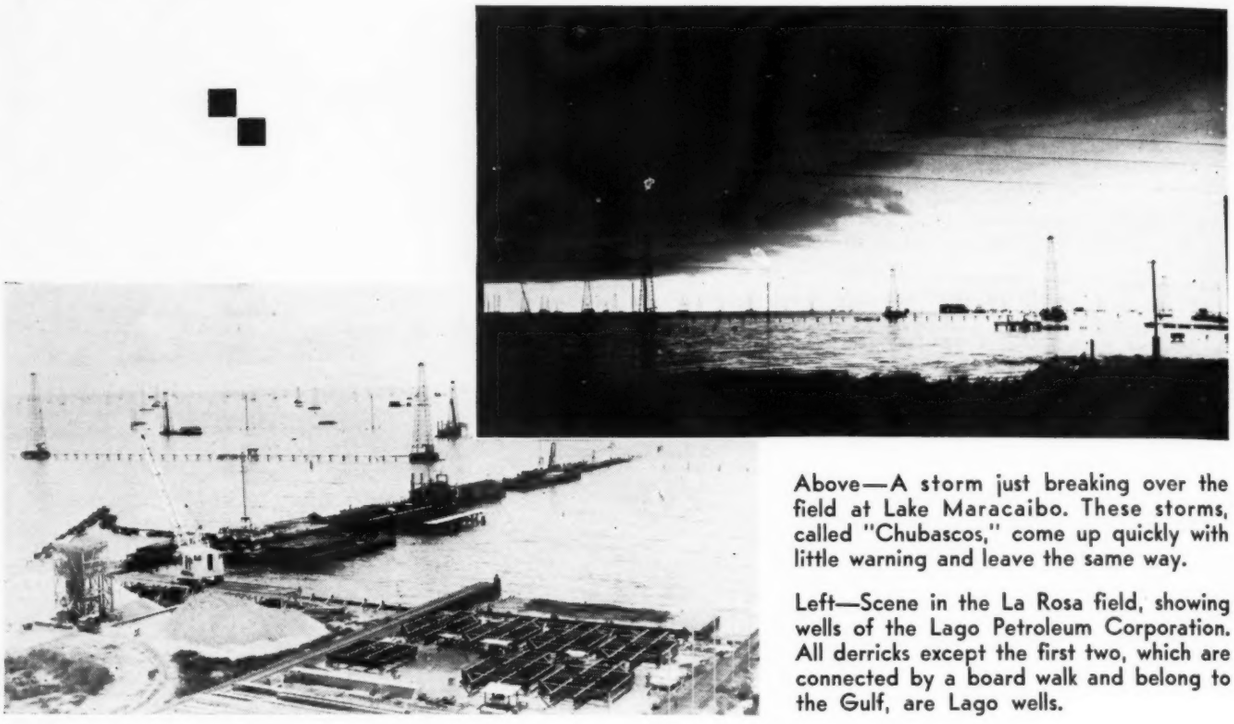
Scenes Taken in Venezuelan Oil Fields



Above—A storm just breaking over the field at Lake Maracaibo. These storms, called "Chubascos," come up quickly with little warning and leave the same way.

Left—Scene in the La Rosa field, showing wells of the Lago Petroleum Corporation. All derricks except the first two, which are connected by a board walk and belong to the Gulf, are Lago wells.

You Can PUMP WELLS for Less Money!

You can always lift oil for less money with a JENSEN Straight-Lift Pumping Unit. Otherwise we wouldn't want your money.

Isn't it worth investigating? Write us at Coffeyville, send us a wire, or see our dealer in your territory.

JENSEN JACKS

JENSEN BROTHERS MANUFACTURING COMPANY
Coffeyville, Kansas, U. S. A.

SAY IT with Cleanliness

"Fire NOT Wanted"

REMOVE those inflammable oil and grease deposits that build up around rigs, derricks, on floors and equipment. You not only greatly increase your safety factor against costly fire losses, but you do it with surprising ease and at negligible cost. Just pressure spray surfaces with the powerful, energetic solution of the recommended Oakite material, and hazardous oil and grease deposits just float away.

Have us give you details about this effective, economical aid to property safety.

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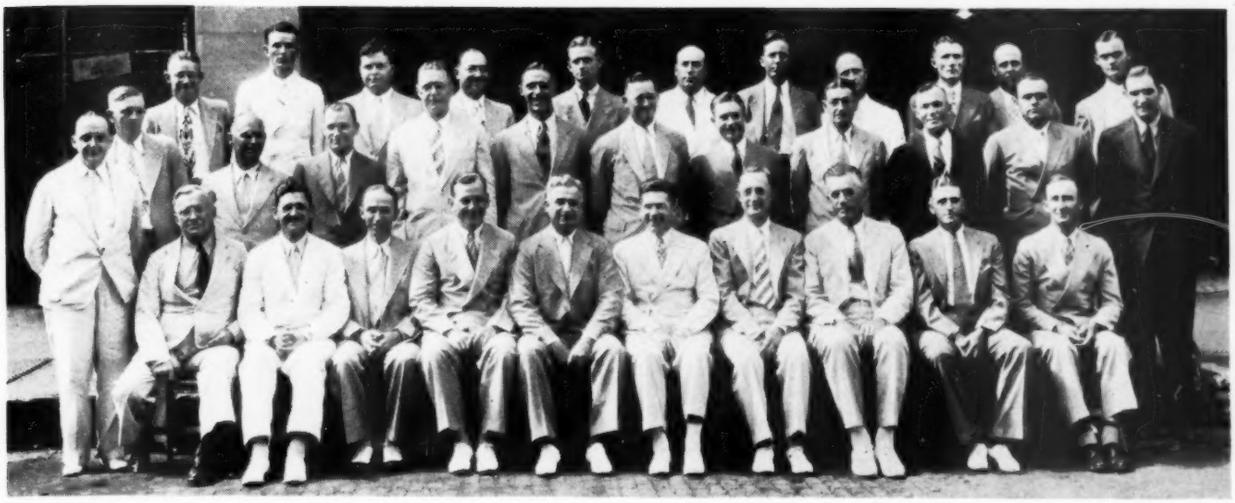
TRADE MARK REG. U.S. PAT. OFF.
SPECIALIZED INDUSTRIAL CLEANING MATERIALS & METHODS

Personnel of Mid-Continent Supply at Recent Meeting in Ft. Worth



First Row (seated), reading from left to right: J. T. Harrington, local manager, Houston; S. W. Backus, district manager, Shreveport; F. John, purchasing agent, Fort Worth; J. A. Daugherty, vice-president, Tulsa; D. H. Thornbury, vice-president, Houston; K. W. Davis, president, Fort Worth; J. C. Halbert, secretary-treasurer, Fort Worth; H. E. Hamilton, district sales manager, Houston; R. C. Tucker, district manager, Midland, R. O. Moore, district manager, Longview.

Second Row, left to right: M. F. Heet, Fort Worth; C. H. Norton, Shreveport; G. H. Canterbury, store manager, Lake Charles; Grady Gray, Fort Worth; O. A. Schilling, Houston; G. W. Walters, Odessa, Texas; F. J. Spurlock, manager pumping equipment sales, Houston; H. H. Brown, Fort Worth; C. L. Hudson, Tulsa; W. I. West, district manager, Houston; A. E. LeClaire, Monahans, Texas; F. R. Files, store manager, Kilgore.

Third Row, left to right: C. R. Brooks, Kilgore; Roy Maness, Lake Charles; R. E. Fuller, Houston; C. M. Fleeman, Rodessa; Earl Barber, Fort Worth; S. H. Carter, Houston; S. W. Woolsey, Houston; G. A. Wead, store manager, Refugio, Texas; P. H. Ligon, Fort Worth; R. L. McAnally, store manager, Kermit, Texas; G. C. Colwell, store manager, Rodessa.

ANOTHER Buckeye GOES down the line

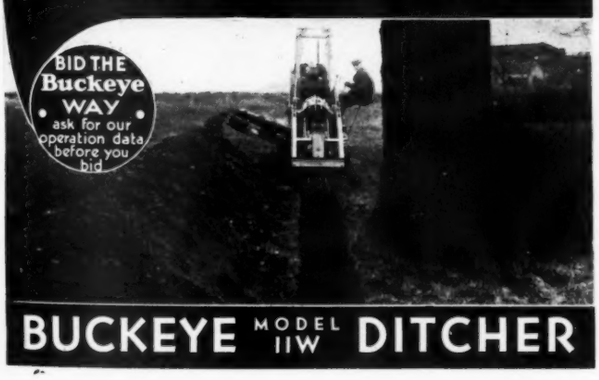
Following the right of way easily and accurately. Digging close to all kinds of obstructions, putting the center of the trench within 26 inches of poles, buildings, trees, etc.

Speedily digging trench from 11½ inches to 22 inches in width and up to 5½ feet deep at a rate from 9 to 332 inches per minute.

Small enough to haul from one job to another, but built for steady, reliable service. Under its own power, it has a road speed of 4.37 miles per hour.

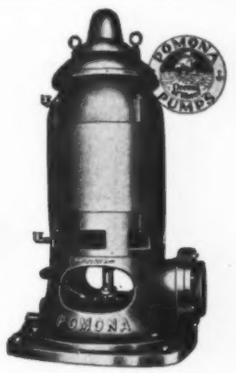
Model IIW is a Buckeye Ditcher you should know about. Ask for complete information.

THE BUCKEYE TRACTION DITCHER CO., FINDLAY, OHIO



BUCKEYE MODEL IIW DITCHER

DO YOU BUY DOUBLE?



Are you one of those shrewd individuals who consider two points paramount in any purchase? Have you learned that the results obtained in relation to the price paid is the determining factor in establishing value? If you are such a person, then we know Pomona Pumps will interest you. Consider these things. They are the paramount points. Pomona may not be the cheapest pump to buy, but it is the most economical to own. Pomona may not produce more water from a given source, but it will produce it with less operating expense. Pomona may not make extravagant claims of momentary efficiencies, but it will establish them through trouble-free, multi-year service on the job. Be wise, buy double, buy Pomona.

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POMONA TURBINE PUMPS

HERCULES "Type A" Cast Steel Casing Head with Slips

SEND EFFICIENCY UP

with

"OVERHEAD-PACKED" HEADS

HERCULES "Overhead-Packed" Cast Steel and Forged Steel Casing Heads have been *perfected* in every detail. Note these desirable features:

HERCULES "OVERHEAD-PACKING" arrangement permits repacking and adjustment of pressure on packing *without lifting casing or disturbing well connections.* Split steel and split rubber packing rings make a gas-tight pack *above* the slips.

BUILT STRICTLY TO A.P.I. SPECIFICATIONS.

CASING REDUCTION SIMPLIFIED by using smaller head on inside string.

SPECIALLY DESIGNED SLIPS conform to the casing and taper inside the head—yet cannot foul or hang.

CAN BE FURNISHED WITH MANDREL. Two 3" side outlets. Tie-down lugs furnished on order.

The HERCULES "Type A" Cast Steel Casing Head is tested for 3,000 pounds. However, for well pressures up to 7,000 pounds we recommend our "Type B" Forged Steel Head. "Type B" is made of special forgings and is completely machined inside and out. All parts interchange in both Heads. *Details in Composite Catalog, Pages 629-631, or write for Bulletins Nos. 17 and 18.*

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Book Reviews

Petroleum Development and Technology (1936). Transactions of the American Institute of Mining and Metallugical Engineers, Petroleum Division, Vol. 118. Published by the Institute, 29 West 39th Street, New York, N. Y. 536 pages. Cloth. Price, $5.00 net.

This most recent volume of the Petroleum Development and Technology series of the Petroleum Division of the A.I.M.E. contains papers presented before the Division at Houston, Texas, October 10-12, 1935, and at New York City, February 17-21, 1936.

Chapter 1 is concerned with an estimation of petroleum reserves. Chapter 2 contains papers on production engineering, Chapter 3 deals with petroleum economics, Chapter 4 gives information on domestic and foreign production, and the final chapter in the book is on engineering progress in petroleum refining during 1935.

Contributions in the chapter on production engineering are: "Experiments on the Vertical Flow of Gas-liquid Mixtures in Glass Pipes," by J. E. Gosline; "Structure of Clay Gels," by W. K. Lewis, Lombard Squires, and W. I. Thompson; "Determination of Surface Tension and Specific Gravity of Crude Oil Under Reservoir Conditions," by D. T. Jones; "An Investigation of Experimental Methods of Determining Sucker-Rod Loads," by Emory Kemler; "Laboratory Investigations of Acid Treatment of Oil Sands," by F. B. Plummer and R. B. Newcome, Jr.; "Investigations on the Recovery of Oil from Sandstones by Gas Drive," by Gerald L. Hassler, Raymond R. Rice, and Erwin H. Leeman; "Water-flooding in the Mid-Continent," by George H. Fancher and Kenneth B. Barnes; "Chemical Methods for Shutting off Water in Oil and Gas Wells," by H. T. Kennedy; "Plug-back Cementing Methods," by C. P. Parsons; "Insoluble Residue Methods and Their Application to Oil Exploitation Problems," by G. Burpee and W. L. Wilgus; "Salt Water—Its Value, Its Control, Its Disposal, Its Cost," by H. K. Arnold; "Casing Perforation by Gunfire and Its Application to Oil Production," by E. R. Smith; "The Kettleman Hills Subsurface Pressure Survey by the California Oil Umpire," by W. H. Osgood; "Futuristic Methods for Oilfield Development and Production," by V. H. Wilhelm.

The Petroleum Register (17th annual edition). Published by Petroleum Register Corp., 165 Broadway, New York City. 875 pages. Price: $10.00.

This directory, statistical record, and equipment catalog of the petroleum industry, international in scope, is the largest volume of the Register published since 1917 and contains information on 23,000 oil companies in addition to its many other features. Virtually every section has been enlarged in the 1936 issue.

The various sections include:

A buyer's guide consisting of more than 270 pages, listing practically every article used in the various branches of the petroleum industry. Under each heading are names of from one to 50 manufacturers or distributors.

Detailed information, such as officers, branches, purchasing agents, superintendents, location of plants, etc., is given on more than 500 refining companies.

More than 5500 names of crude oil producers are listed.

A total of 10,000 names of distributors of petroleum products are arranged according to states.

The section on refineries and refinery superintendents

gives names of 700 refineries arranged according to states. Each listing includes location of plant, capacity, etc., and the name of the superintendent.

Other sections contain lists of vessels carrying petroleum products in bulk, compounders and grease manufacturers, natural gasoline manufacturers, pipe line companies, reports on foreign countries, trade and brand names, drilling contractors, royalty companies, oil company executives, exporters, natural gasoline plants. In addition there is a section on marine transportation and lighterage, as well as a statistical section.

Mid-Continent Supply Opens Dallas Office

The Mid-Continent Supply Company, with headquarters at Fort Worth Texas, has opened a sales office at Dallas, 1111 Magnolia Building, in charge of H. H. Brown, well known in the oil well supply industry.

Two Booklets on Cummins Diesels

Two new booklets have just been released by the Cummins Engine Company of Columbus, Indiana, dealing with their line of industrial engines that range in power from 55 hp. to 200 hp. It is attractively prepared and illustrates many types and applications of industrial engines built by the Cummins factory. The other bulletin just issued deals with fuel injection systems and the difference between the individual pump of the high-pressure type and the company's low-pressure distributor type fuel pump. Copies of these booklets may be obtained by writing direct to the Cummins Engine Company.

A. I. M. E. to Meet in Los Angeles

The next meeting of the petroleum division of the American Institute of Mining Engineers will be held at Los Angeles on October 1 and 2.

The importance of the Institute meeting is indicated by the fact that the president, John M. Lovejoy, who is also president of the Seaboard Oil Corporation, will be in attendance. George Otis Smith, former director of the U. S. Geological Survey and also past president of the Institute, is scheduled to be present and address the meeting.

A number of the most prominent executives of the California oil companies are participating in arrangements for the coming meeting and will deliver addresses. A large attendance of oil men is expected.

M. O. Johnston Makes Extensive Trip

M. O. Johnston, president of the M. O. Johnston Oil Field Service Corporation, Los Angeles, accompanied by Mrs. Johnston and Mr. and Mrs. A. E. Mires, recently returned from a month's vacation and business trip that took the party through Utah, Wyoming, the Jackson Hole Country, Montana, Washington, Idaho, Oregon, and various parts of Canada.

On this trip Johnston made a survey of drilling operations in the various oil districts with the intent of establishing service branches for his formation testing business in the very near future.

While in Wyoming the Johnstons attended the annual Cheyenne Rodeo as the guests of Mr. and Mrs. S. W. "Red" Hardison.

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WATER CANS
& COOLERS
GOTT Water Cans are the practical way to keep drinking water cool for long periods, protected from impurities and always handy to the job. Snug fitting large removable top, strongly built to withstand rough usage. GOTT Water Coolers have extra large covers and a handy non-leaking push button faucet. Your Supply Store has them, get one today! . . . . .
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Made in 1½, 3, 5, and 10 gallon sizes.
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H. P. GOTT MFG. CO.
WINFIELD, KANSAS
KEEP PURE DRINKING WATER ALWAYS HANDY

Look for the *Arm-and-Hammer*

ARMSTRONG BROS.

BACK-UP CHAIN TONGS

Oversize master links and lead links (first 5), in fact the entire chain is oversize, has extra strength that can be depended on under the most severe conditions. These Back-up Tongs embody all of those quality features that distinguish *all* ARMSTRONG BROS. Chain Tongs:

Handles forged from high carbon steel; have both stiffness and spring.

Jaws drop forged from special steel, treated, hardened and tested for wearing quality and toughness.

Chains proof-tested to two-thirds catalog strength (proven strength).

Five Types All Sizes Write for Catalog.

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MODERN HORIZONTAL BORING MACHINE
For Underground Installation of Pipe and Conduits. Avoids damage to costly pavements and saves time. Send for Bulletin.
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UNDERGROUND WELL SURVEYING SERVICE

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Troubled with Tubing Bridges? . . . Use The

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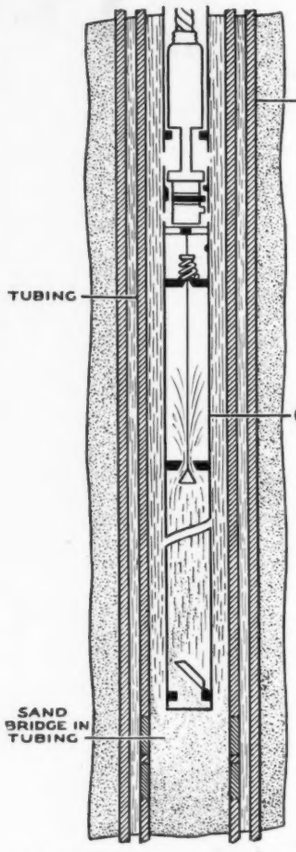

The effectiveness of The Cavins for cleaning out Tubing Bridges was forcefully demonstrated recently in the Mountain View field in California.

A well which had been flowing through 2⅞" tubing had bridged over for about 500 feet in the tubing. Use of a 2⅛" Cavins for breaking and cleaning out this sand bridge eliminated the hazardous task of killing the well to pull the tubing, thus risking permanent damage with the possibility that the well might get away during the pulling operations.

While cleaning out, the well was allowed to flow through the casing and establish a potential. The well was cleaned out in two days with The Cavins, and again flowed through the tubing. As a result, expense was kept to minimum, not a barrel of production was lost, and the well was as good as ever when returned to flowing through the tubing.

Use of The Cavins for cleaning out sand bridges will save time, money and production and assure the safety of the well. Write for Bulletin No. 36.

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Only BJ CAN MAKE AN ELEVATOR SO SAFE AND SO EFFICIENT

The BJ Side-Door Slip Elevator is today being used successfully in oil fields around the world. It has many times the capacity required to handle the longest and heaviest strings of casing by means of four long slips which grip the pipe at any desired point. None of the weight is carried by the coupling or collar.

It is extremely simple in operation and a patented "balancing" device makes this elevator as easy to handle as any side-door elevator, only one man being needed on the derrick board when setting casing.

Read other details on this page, then see Pages 298 to 300 of the 1936 Composite Catalog for sizes and prices; or write the office nearest you for the BJ Catalog.

SIDE-DOOR CONVENIENCE

Due to the BJ "Side-Door" construction, this elevator can be placed on or removed from the casing without disturbing circulating or cement heads. This important feature is not possible with "doughnut" or solid-type slip elevators.

LARGE, SAFE SLIPS

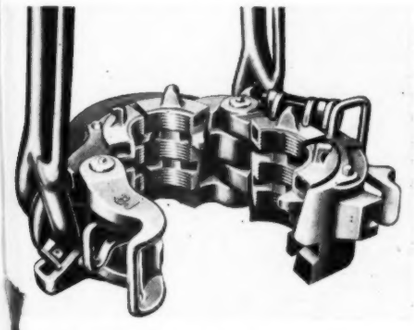
The door and body of this elevator contain four interlocking spring-floated slips which set evenly and uniformly around the entire circumference of the pipe. Due to the large area of these slips it is practically impossible to bottleneck or crush the pipe, even under the heaviest loads. The slips release instantly and will not stick on the pipe, but are retained by a bolt which prevents their being lifted or jarred from the elevator.

TWO WAYS TO SET SLIPS

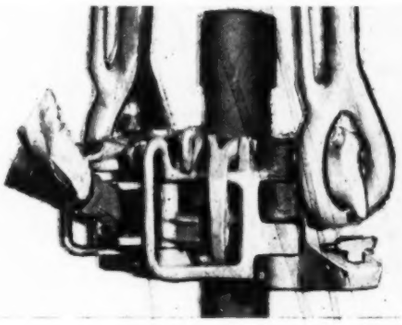
It is impossible for the pipe collar or external upset to pass through the slips after the elevator is closed. The slips are automatically set when contacted by the collar or external upset, thus providing a safe setting method used by many operators. Other operators prefer to set the slips at a point several inches below the pipe collar, which is easily done by the slip-setting handle pictured below. This feature is very desirable when setting flush joint casing.

NO ACCIDENTAL RELEASE OF SLIPS

A new safety feature is a manually operated slip lock (illustrated below) which eliminates danger of having the slips disengage in event the casing hangs up on some obstruction while being lowered in the well.



The interlocking slips and safe construction of door and latch are clearly shown above.



The "Balanced" elevator is easily operated by means of the large, convenient handles.

Operating the slip-setting handle to grip at any desired point.

With slip-lock set, the slips retain their grip on casing, safe from accidental release.

BJ SIDE-DOOR SLIP CASING ELEVATOR

BJ

MULTIPLE STAGE CEMENTIN

Many wells call for the placing of stages of cement at separate points behind the casing ..... Through MULTIPLE STAGE CEMENTING, each stage is carried directly to its destin..... No unnecessary travel..... n...rs..... 50% reduction in pump pressure..... Provide safety against dangerous blowouts..... protects and conserves shallow productive formations for later development..... has effected direct savings amounting to several thousand dollars per well..... Write for folder.

HALLI... OIL WELL CEMENTING COMPANY

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